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[Official Notice.]

NEW ENGLAND ASSOCIATION OF GAS ENGINEERS.

The annual meeting of the Association will be held at the Tremont House, Boston, on Wednesday, February 19th, 1878, at 12 o'clock, noon.

Members intending to propose any persons for membership at the annual meeting, are requested to send to the Secretary the names of such persons as soon as possible.

George B. Neal, *Secretary.*

Boston, Jan. 14th, 1879.

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G. WARREN DRESSER, Editor,

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THE OUTLOOK FOR 1879.

From all directions the reports indicate a much better feeling in all business circles than has existed for several years. The economies which have been forced upon every one, the steady increase of our exports accompanied by a continued small amount of imports, the resumption of specie payments by the government, at the time fixed by the law of the land, which favorable circumstances happened to make coincident with the inflexible laws of supply and demand, so that nothing was forced; all these must tend to make this improvement real and permanent. At the close of the second week in the new year, the New York *Express*, in its financial article, thus speaks of the situation:

"The events of the week in financial circles were very important, especially as indicating the marked progress made in the revival of confidence and in the preparations for business in the future growing out of the success of resumption of specie payments generally. A new life seems to have been infused into financial and commercial affairs; capital is no longer timid; the depression which, since 1873, has stalked throughout the land, has at last disappeared, and in its place we have cheerfulness and an increased disposition to enter into new business operations; real estate, which has been at such a low ebb for years, is looking up, and has assumed a new value; capitalists no longer hoard their money, but invest it in securities, in real estate, or in legitimate business; new and enlarged foreign markets are being constantly found for our domestic manufactures; our exports exceed our imports by $267,000,000 a year, and from all appearances this improved condition of our foreign trade will be even more marked in the future; our railways are kept actively employed by the great internal commerce of the country, which is growing every year; immigration is on the increase, and the area of land under cultivation next spring and summer will be larger than ever before, and, in fact, everywhere the indications of returning prosperity are so plain that he who runs may read. The feature of the market was the immense subscriptions to the four per cent. loan. In railroad mortgages the transactions were larger than for any previous week for months past, aggregating $7,000,000. Nearly the entire list advanced under the enormous investment inquiry, the improvement ranging from 1 to 7 per cent."

We are happy to inform our readers that the prices obtained for gas stocks in this market, when sold at auction, are much better, the advance being equal to about 10 per cent. already. In spite of the great clamor about electric light, we see no reason why the "send out" for 1879 should not exceed that of any one of several years past by a very handsome percentage.

The benefits from the electric light agitation to the profession are already becoming apparent in the development of new methods of using gas for mechanical and domestic purposes, and in the production of better burners. During the past week 50 of Sugg's new *double* r[illegible] burners have arrived for use in the new C[illegible]al at Albany. These burners give a light of ov[illegible] 50 candles for 13 feet of gas. This is a new [illegible] in the right direction.

The Chartered Company, in London, have applied to the Metropolitan Board of Works for permission to show what gas can do side by side with electric light at the Westminster Bridge; and, evidently, the company does not in the least fear the result even though the Thames Embankment, the Holborn Viaduct and the Billingsgate Market are enveloped in the moonlight brilliancy of the "light of the future."

The Chartered Company express "the desire of the Company to offer the Board every facility so far as lies within their means, in connection with the experiment now being made with the electric light, and stating that they are anxious for the opportunity of displaying the comparative powers of illuminating by gas, and requesting permission to make such temporary alterations in, or additions to, the public lamps at the 'refuge' at the Middlesex end of Westminster Bridge as may be desirable."

From the Cologne *Gazette*, of Dec. 27, 1878, we extract the following:

"In a large restaurant in this city trials have been made with the electric light which had to be abandoned, because the light, which was placed at several points in the large room, did not sufficiently illuminate all parts of the room. The guests complained of their eyes being affected, and some of them complained of ill effects in the head. One good result from this unsuccessful experiment with the electric light was that, in another place near by, the writer saw a large gas burner, equal to five ordinary ones, which gave a much more beautiful and brilliant light than five ordinary ones burning alongside of it. This new burner was an argand, with an umbrella-shaped shade, instead of the common globe. This new arrangement was the result of efforts made by the city gas company to improve the illumination by gas. This will be of interest to your readers because there are speculators who, availing themselves of the electric light excitement, are endeavoring to depress the price of gas investments. Dr. Siemens, the distinguished electrician, upon the introduction of the electric light at the Parliament buildings, stated that the panic in gas stocks was without any foundation, because, with the introduction of electric lighting, the consumption of gas will not be diminished but increased."

From all this, and many similar expressions, we conclude that the outlook for 1879 is exceedingly favorable.

CHARLES F. DIETERICH'S NEW METHOD OF HEATING BENCHES.

A Paper Read before the Society of Gas-Lighting, Dec. 12th, 1878, by G. Warren Dresser, C. E.

About the middle of the month of December I visited Baltimore for the purpose of examining the system of heating benches devised and put into practical operation, by Mr. Chas. F. Dieterich, the Engineer of the Peoples Gas-Light Company, of Baltimore, Maryland.

One entire range of twenty benches has been adapted to the use of the new furnaces, and of these as many as were required for the entire daily make of the works were in action, so that the working was a practical retort house working for the whole make, and not an experimental bench.

The principle upon which the furnaces are constructed is to secure the combustion of the carbonic oxide gases from the coke, by means of heated air introduced at the point where the gases enter the oven. To effect this the furnace is built outside, and just in front of the bench, and below the level of the retort house floor. It is very simple in form, being on the inside 14″ wide, 5′ deep, and 2′ 6″ long. The inner lining is of fire-brick, 12 inches thick. Outside of this is an air space, all around, 6 inches wide, and outside of this a 12 inch brick wall. In the air space galvanized iron pipes of rectangular cross section, about 4″×6″, are introduced on each side of the furnace leading from the bottom of the air space, where they take in the outer air by means of stoppers, and pass back and forth in a zig-zag manner, towards the top and back of the furnace, into a small chamber on each side whence the air (having become heated) passes into the throat of the furnace flue in finely-divided streams by means of nostrils or openings. This point is very nearly the same, in relative position, as the common furnace occupies in the ordinary setting. The top of the furnace is covered by tiles of fire-brick, set in an iron frame, and this in turn by an iron cover standing a few inches above it, with a rim projecting downwards into a sand seal. When these covers are on, the top of the furnace is practically air-tight.

At the bottom of the furnace, grate-bars similar to the ordinary ones extend the whole length of the furnace, and beneath them is an ordinary ash-pan. The grate bars are supplied with two sets of bearing bars, one at the level of the bottom of an ordinary furnace door, and another about six or eight inches above; this is for convenience in clinkering, which is done by withdrawing a portion of the bars from the lower or permanent rest, and driving these through the fire above the upper ones—this holds the body of coke in place in the furnace—then the remainder of the lower bars are withdrawn, the clinker which has accumulated at the bottom of the fire allowed to fall into the ash-pan; then the bars are replaced, and those above are drawn out and put in their place below, the fire settles down on to the grate, and the operation is completed—the whole requiring about three minutes. This operation is necessary only *once in eight hours.*

When the charge in the retorts is burned off, the cover is taken off of the furnace, the lids of the two lower retorts are struck, and the hot coke raked directly from the retorts into the furnace beneath, which, upon being properly filled, is immediately covered, and the two lower retorts are recharged, after which the upper retorts are drawn into barrows and the coke removed to the yard as usual. The custom at the works referred to is to draw several of the lower sets of retorts in different benches in succession, and then return to draw the upper ones.

The advantages resulting from this arrangement of furnace are several:

1st. A more perfectly uniform heat throughout the bench than I have ever seen by any other method. The retorts appear to be uniformly heated up to the mouth pieces. The upper and lower retorts are heated alike. There is no flame to be seen in the bench by taking out any one of the stoppers. There is no flame at the chimney top on the top of the bench, excepting at the moment of clinkering. No *cold* air can possibly get into the bench.

2d. The charges are as thoroughly burned off in *three* hours as they would be in *four* hours by the old method. The retorts in question were 12″×20″×8′6″, and I saw a charge of 1250 lbs. per bench of sixes as handsomely burned off in three hours as it is usual to see in running four hour charges, and the heats were not excessively high, judging by the color of the retorts and the appearance of the interior of the ovens.

3d. The illuminating power of the gas is fully equal to that obtained by the old method, with the same coals, and a slightly smaller percentage of cannel.

4th. The character of the labor required of the men is not nearly so trying as by the old system. The stokers have no fires to attend or clinker, which all know is by far the most exhausting labor in the retort-house; and, although they have to charge and draw oftener, the work is easier than where the fires have to be attended, and the charges are less frequent.

The skill required for keeping the fires going, and keeping the heats up, is reduced to a minimum, as one man can attend the fires for 14 benches, with great ease, and from the arrangement for clinkering referred to above, very little practice will enable any one to manage the fires. In case of a strike this is an important item.

5th. One-third of the coke made is more than enough to keep the furnaces supplied with fuel—although this would depend upon the character of the coal used, and the coke obtained from it.

6th. It can be adapted to any bench without disturbing the present arrangement of retorts.

As evidence upon some of these points I give below figures taken from the daily report book for the months of October and November 1877 and 1878. During these months in 1877 the workings were by the old system, and during the same months in 1878 the workings were by the new.

October.	1877	1878.
No. Retorts in use, daily average for month	77	59
Coal carbonized, tons, total for month	1203·36	1060·85
Coal carbonized, lbs. per retort, each charge	186·72	185·94
Gas made, cu. ft., per retort in 24 hours	5471	6478
Gas made, cu. ft., per lb. of coal	4·88	4·99
Illuminating power, candles	17	17·11
Duration of charge, hours	4	½mth. 4 : ½mth. 3
Coke made per ton, bushels	38 to 40	38 to 40
Coke burned in furnace, bushels per bench	80	52
Coal used	2-3 Fairmount. 1-3 Coal Valley, 5 p.c. Cannelton.	Fairmount. 2½ p.c. Cannelton.
Total gas made in month, cu.f.	13,319,200	11,856,000

November	1877.	1878.
No. of Retorts in use, daily average for month	96	63
Coal carbonized, tons total	1361·76	1255·94
Coal carbonized, lbs. per retort, each charge	176·52	184·59
Gas made, cu. ft., per retort in 24 hours	5101	7156
Gas made per lb. of coal, cu. f.	4·81	4·84
Illuminating power (city Inspector) candles, average	17	17·5
Duration of charge, hours	4	3
Coke made per ton, bushels	38 to 40	38 to 40
Coke burned in furnaces, bushels per bench	78	51·48
Coal used	2-3 Blacksburg 1-3 Fairmount 5 p.c. Cannelton	Fairmount. 2½ p. c. Cannelton.
Total gas made in month, cu.f.	14,693,000	13,612,000

Owing to the peculiar method of regulating the lighting of the street lamps in Baltimore, it is often necessary to keep more retorts fired up than can be used to advantage.

It is evident that by this system, from the figures given, the same (or even larger) charges may be burned off in three hours than were formerly burned off in four; or, in other words, the same gas made in three hours which by the old method required four hours.

This is equal to increasing the capacity of the retort-house 33 per cent.; for, in 24 hours, 8×1250=10,000 pounds of coal are carbonized per bench, instead of 6×1250=7500 pounds.

The wear and tear upon the bench must also be reduced, inasmuch as the heats are kept much more constant and uniform; and even when retorts are "missed," their cracking is much less frequent.

This furnace can be adapted to any bench without disturbing the settings in any respect, except by the removal of the common furnace and ash-pan. Certainly it appears, when viewed in operation as it is in Baltimore, working practically throughout all the benches in use, that this no experiment; and it is worthy of careful study, inasmuch as it enables the gas maker to turn out a larger product from his apparatus, with less and lighter labor, and must result in lessening the cost of making.

The depth to which it is necessary to go below the ordinary retort-house floor level is about seven feet six inches. The details of adapting it would, of course, have to be worked out for each case; but where there are retort-house cellars, the easiest case would occur, as no excavations would be required.

The cost of the material and work necessary for putting the furnace in working order under a bench would vary from three hundred to five hundred dollars.

LECTURE UPON THE ELECTRIC LIGHT.

Delivered Oct. 17, 1878, Before the American Gas-Light Association,

By Prof. HENRY MORTON, Ph.D.,

Pres. Stevens Inst., Hoboken, N. J.

[Continued from page 7.]

The first attempt to make a magneto-electric machine of such a size as to be available for industrial purposes, was made in 1849, by M. Nollet, Professor of Physics at the Military School at Brussels.

The original intention of those first engaged in developing this machine was not, however, to produce with it an electric light, but to employ it to *decompose water in order that the hydrogen so liberated might be used as an agent of illumination.* If we were in want of an illustration of the extravagance and irrationality of expectation which so often exhibits itself in enterprises entering upon new fields, we surely need go no further than this. M. Nollet died before his designs were entirely carried out; but they were elaborated by an intelligent workman who had assisted him in the construction of his machines, M. Joseph Van Malderen, who, under the auspices of a company composed of French and English capitalists, and named the "Alliance Company," developed the apparatus into an efficient generator of electric currents for the direct production of light by means of the electric arc.

The apparatus, as thus constructed, was, in general principle, only an enlargement of the Clarke machine (already shown), and consisted of a large number of compound steel magnets, between the adjacent sides of which cores of soft iron, surrounded with coils of insulated wires, were made to revolve. An appropriate connection of these various coils with each other, and with commutators on the axis, enables the current to be taken off in a constant direction. When it was afterwards discovered that, for an electric light, the current need not be constant in direction, but was even more convenient when rapidly alternating, this was of course yet more easily provided for. Fig. 18 shows one of these Alliance machines, which really

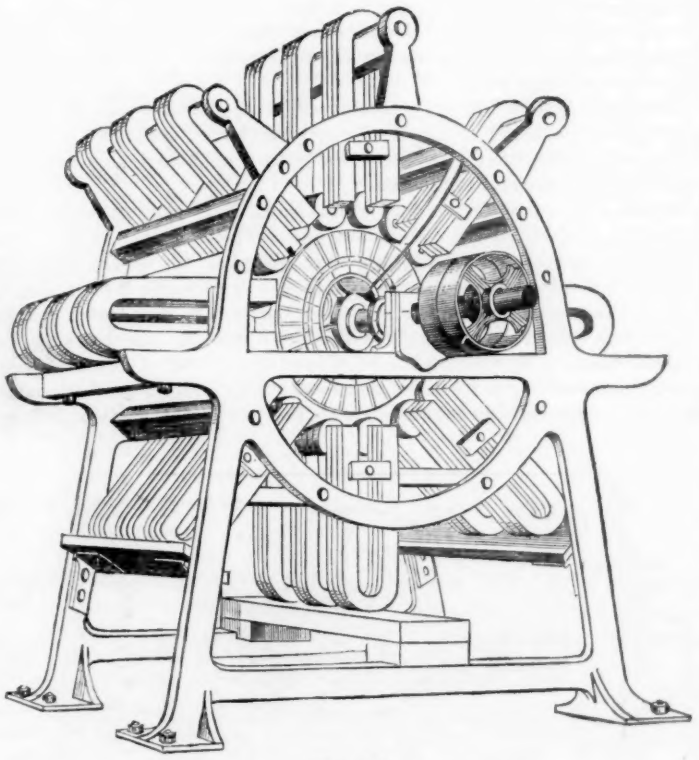

Fig. 18.

needs no further description, but is rendered perfectly clear in its structure and operation by the cut.

Many of these "Alliance machines" were made and used in different places in France for lighting works of construction at night, such as the Cherbourg docks, and on some vessels as the Lafayette and the Jerome Napoleon, and in some lighthouses; and, as modified slightly in arrangement of parts by Mr. Holmes, in England, notably in the South Foreland lighthouse.

The great cost of these machines, the large amount of power required to run them, and the cost and trouble of keeping them in repair, however, limited their use to a very narrow field, and they could hardly be said to have carried the subject of electric lighting beyond the range of an interesting scientific experiment on a large scale.

The next important step in the development of the magneto-electric machine consists in the application by Dr. Siemens of his peculiar armature to these instruments.

This armature is shown in longitudinal section in Fig. 19, at E, and in cross section at F.

Fig. 19.

The armature is in fact a rod or bar of soft iron, with deep grooves cut lengthwise along it, reducing its section to an H form, as is shown in F. Insulated wire is then wound lengthwise in these grooves, as shown in E. Such an armature as this, mounted with caps, as shown in Fig. 19, may then be rotated in a very narrow and dense magnetic field, and its wires will cut many lines of magnetic force in a short time by reason of their rapidity of angular movement, being close to the axis of rotation.

This armature was first used in magneto-electric machines employed for telegraphing by Siemens, in 1857.

The next advance, and this a very marked one, was made in 1866, by H. Wilde, of Manchester, who, on April 13, communicated to the Royal Society the result of a series of experiments with magneto-electric machines, of which Fig. 20 is a good representative.

In this machine a number of small horse-shoe magnets are so arranged that a Siemens' armature may be rotated between their poles.

The coils on this armature have developed in them, by moving in this highly concentrated magnetic field, a very powerful current. This current is then passed through heavy coils of wire surrounding the sides of a large U magnet, made of massive plates of wrought iron. Between the poles of this rotates another Siemens' armature of larger size, from which a current of immense power is obtained.

While the electric current developed by this machine far exceeded anything which had ever been obtained before, it was only secured by a large expenditure of power—something between a five and a twenty-horse power engine being required to drive it.

The important fact developed by Mr. Wilde in this machine was that a magneto-electric machine could develop a current whose magnetizing power

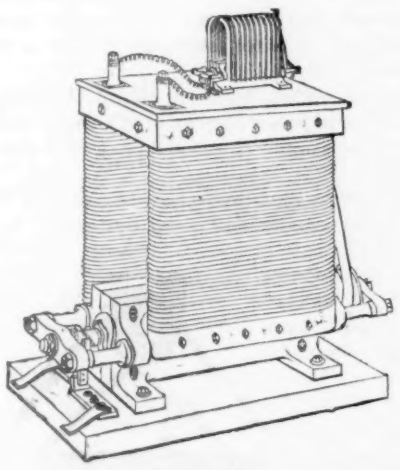

Fig. 20.

was vastly greater than that of the magnets from which it was derived. Thus, if the small magnets above would lift a weight of 50 pounds, the large electro-magnet below, when excited through their instrumentality, would lift 500 pounds or more. This possibility of a sort of magnetic accumulation or growth was a demonstration of immense value to the progress of magneto-electric science.

A practical difficulty which first showed itself in a conspicuous degree in these very powerful machines was the heating of the armature. Foucault had first shown, long before, that when a conductor was rotated or moved in a magnetic field it became strongly heated.

His apparatus to illustrate this is shown in Fig. 21, where a copper disc is rotated between the poles of a powerful magnet, and becomes very hot.

Tyndall, by similarly rotating a copper tube, melted the fusible metal with which it had been filled.

The heat developed in the armatures of Wilde's large machines was so great as to cause serious inconvenience, and of course involved a great loss of effect or waste of power.

In 1867 Siemens proposed a very obvious modification of this machine of Wilde, by dispensing with the smaller machine and connecting the coils of the large one with its own armature through the commutator of the same.

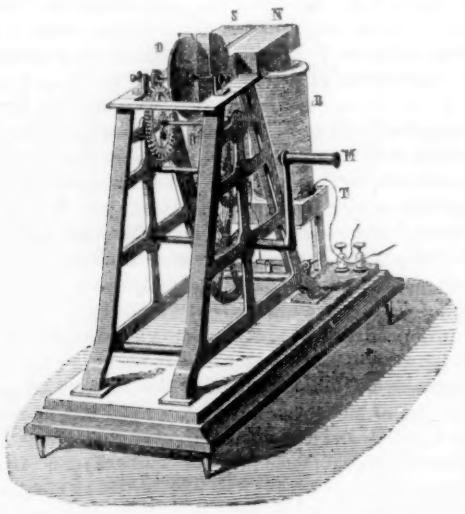

Fig. 21.

The residual magnetism of the iron of the electro-magnet was found sufficient to start the action, which then increased by self-development.

This, however, occasioned what was at first regarded as a serious difficulty.

If the magnetism of the electro-magnet was thus made to depend on the current of the machine itself, any interruption in the flow of the same in the exterior circuit at once cut down or destroyed this magnetism, and so reduced the whole action.

To obviate this, Ladd, of London, first made a machine with an armature wound with two coils of wire, one being connected with the magnet of the machine, and the other with the exterior circuit.

Afterward he made a machine in the form shown in Fig. 22, where two armatures were used—one connected with the coils of the machine itself, and thus supplying what is often called the "field of force," the other supplying the exterior circuit.

Subsequent experiment has, however, shown that the arrangement is very far from economical in the conversion of energy, and all the machines now in use include the exterior circuit and the field of force in one continuous connection.

This, of course, greatly complicates the relations, and makes the fluctuations during running greater and more numerous; but for the sake of

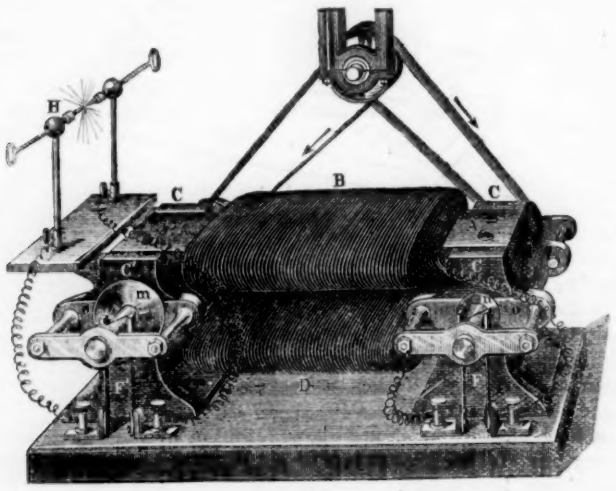

Fig. 22.

efficiency or the economy of expended power, it has been found essential to adopt this arrangement.

PACINOTTI'S RING MACHINE.

The first magneto-electric machine for the production of an electric current continuous in character and constant in direction and intensity, was that devised by Dr. Antonio Pacinotti, in 1860, and constructed by him for the physical and technological cabinet of the University of Pisa. A description of it, however, did not appear till several years later in the June, 1864, number of the Italian scientific periodical, "Il Nuovo Cimento." This number, which was published during the month of March, 1865, contained an extended illustrated description of the machine.

As a special feature of the apparatus he pointed out the peculiar form of the movable electro-magnet—a circular iron ring in which, contrary to the

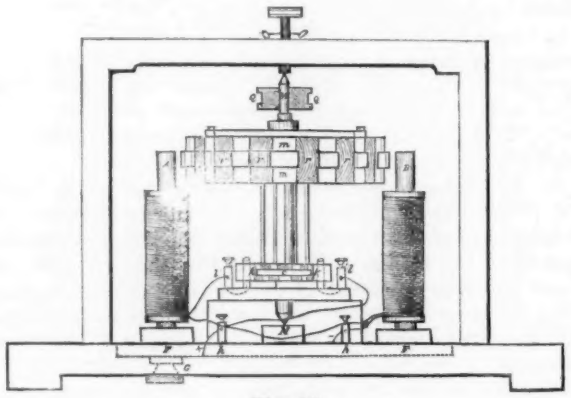

Fig. 23.

case with the armatures previously in use, the magnetic poles did not remain stationary, but could be moved within the ring—that is, made to assume in it successively all possible different positions.

This movable ring of iron had the shape of a spur wheel of 16 teeth, and was firmly secured to the axis of the machine by means of four strips of brass. Small wooden wedges were placed upon the teeth of the ring, and the space so formed between each two of the wedges filled up regularly with insulated copper wire. These spools were all wound in the same direction, and the terminal end of each was soldered to the beginning of the one succeeding it, so that the whole system of 16 spools virtually formed a single coil of wire surrounding the ring in a regular manner, and returning upon itself.

Wires were soldered to the separate points of juncture and were led, parallel to the axis of rotation, to an equal number of insulated pieces of brass, mounted in two rows upon, and slightly projecting from, the surface of a disc firmly secured to the axis.

The iron ring, with the bobbins wound upon it in the manner already described, was mounted in a horizontal position between the two legs of a powerful upright electro-magnet, the distance of which from the ring could be adjusted at pleasure by means of a set screw and a slot in the lower connecting cross-piece. Contact rollers, *k k*, were made to press, one on each side of the axis, against the lower wooden disc carrying the strips of brass, so that during the rotation of the ring all of the latter were brought successively into contact with them. When, therefore, the terminal posts, *h h'*, are placed in connection with the poles of a galvanic battery,

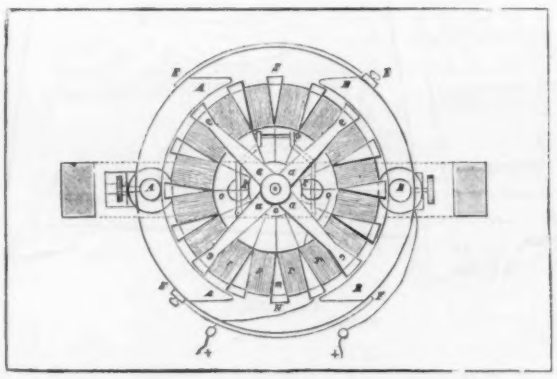

Fig. 24.

the current will pass, supposing it to enter at *h* (+), by way of the binding post, *l*, to the roller, *k*, and through the strip of brass on the disc against which the roller may happen to press at the time, up to the two wire coils of the armature whose point of juncture is in connection with this strip of brass.

The current here divides, each portion passing in an opposite direction through the spools surrounding each half circumference of the ring, to

meet again to form one current at the left contact roller, *k*, from where the reunited current passes to the second binding post, *l'*. From here the current proceeds to the leg A of the electro-magnet, circulates around it, and, after acting similarly with regard to the other leg, B, passes back by way of the binding post *h'* to the negative pole of the battery. Magnetic poles thus became developed in the iron ring at the points N S, the position of the contact rollers having been so chosen as to bring about this effect, and the actions of attraction and repulsion taking place between them and the poles of the stationary electro-magnet gave rise to the rotation of the ring.

In order to turn the action of the electro-magnet upon the magnetized iron ring to the greatest possible account, Pacinotti provided the two poles with armatures, AAA, BBB, of soft iron, which were made to surround the ring very closely for over two-thirds of its circumference. Strips of brass, EE, FF, attached, served to give them greater security. In the elevation of the machine here given these armature have been omitted in order not to conceal the ring and its surrounding spools.

The foregoing description of the ring of Pacinotti and its action has more especial reference to its application in an electro-magnetic machine, but toward the end of his article Pacinotti clearly indicates in what way, by the use of the same annular armature, the electro-magnetic may be converted into a magneto-electric machine, capable of producing, by the proper use in connection with it of a permanent or electro-magnet, a continuous current of a constant direction.

On substituting for the electro-magnet AB a permanent magnet, and on rotating the ring armature, the poles induced in the ring by the proximity of the magnet will always be found at the extremities of the diameter passing, when produced, through the poles of this exterior magnet; so that we may come to consider the spools as alone partaking of the rotary motion, while the two semi-circular magnets produced by the induction remain at rest. The current induced in any particular spool will, in the motion of the latter from N to S, preserve the direction it has on leaving N until it reaches *a*, a point midway between N and S. Here a reversal in direction of the current takes place, which new direction is preserved until the spool arrives at *b*, a point midway between S and N, where a reversal to its former direction of the current occurs, and so the action continues. The currents developed in the different spools will therefore add to each other's effect, and are hence most properly collected at the points A and B, the collecting brushes coming thus to act upon the commutator at right angles to the magnetic axis of the rotating armature.

Pacinotti did actually obtain an uninterrupted current of constant direction on causing the opposite poles of permanent magnets to approach the ring during the rotation of the latter. He also obtained the same effect by magnetizing the stationary electro-magnet by means of a current, though he deemed the former method preferable.

The claim of Pacinotti to priority in the invention and application in magneto-electric machines of the annular armature has already been fully established. and is daily becoming more generally recognized.

SIEMENS-HALSKE MACHINE.

The following description is translated from the admirable treatise entitled "Die Magnet und Dynamo-elektrischen Maschinen," by Dr. H. Schellen, just published:

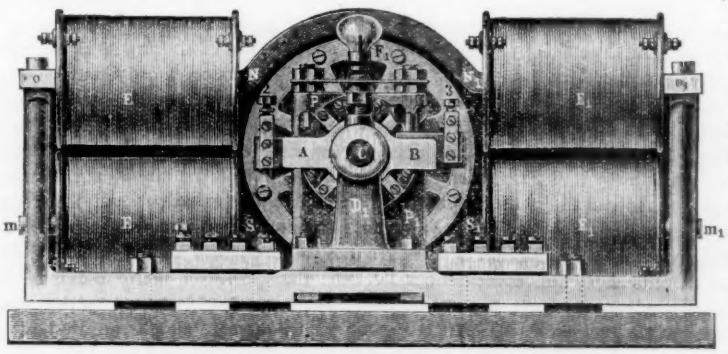

Fig. 25.

"We have already drawn attention to the fact that when metallic bodies are caused to move in a magnetic field, such motion develops in them induced, or so-called Foucault currents, which, if not conducted away, become transformed into heat, and thus, according to the circumstances of the case, give rise to a considerable heating of the metallic bodies in motion. As long, therefore, as the iron core revolves with the coiled drum through the magnetic field of the exterior magnets in the magneto-electric machine just described, these currents are not to be avoided, though they may be diminished to some extent by constructing the armature of coils of iron wire instead of massive iron. In such machines, however, which are built for the purpose of producing very large quantities of electricity, and which for this reason are constructed in accordance with the dynamo-electric principle, these Foucault currents would be attended by a considerable increase in the temperature of the machine, in addition to which considerable power would be required in order to rotate the iron armature, owing to its becoming so strongly polarized by the powerful electro-magnets developed, for which power there would be no equivalent return in useful effect.

"These considerations must have determined the inventor to secure the iron armature inside the drum, and so prevent it from taking part in the motion of the latter in such dynamo-electric machines, like those to be used for illuminating purposes, for instance, as are intended for the production of large quantities of electricity. As a matter of course, this renders the construction and mode of arrangement of the drum much more complicated, and all the more so when it is considered that the long drum, with its surrounding coils of wire, has to be moved through the narrowest possible space between the pole armatures of the electro-magnets and the stationary inner core.

"Figs. 25 and 26 represent the construction, in detail, of such a dynamo-electric machine on the v. Hefner-Alteneck system. A horizontal section of the drum and a side view of the complete machine are there given. *abcd* is a thin German silver drum upon which, in the manner already de-

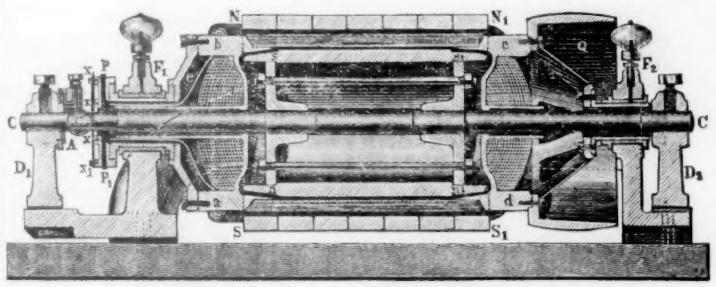

Fig. 26.

scribed, the wire is wound in many circumvolutions, and in eight separate coils. Each terminal face carries a short tube, which tubes form the trunnions of the drum, and which lie in boxes, F_1 and F_2, provided with oil cups. An iron shaft, CC, secured by means of screws in the pillars, D_1 and D_2, passes through these tubes into the interior of the drum, where the core, nn_1, ss_1, held together by two discs bolted to each other, is fastened upon it. The drum is surrounded on the outside at two opposite places for about two thirds of its circumference, and over its entire length, by two curved iron armatures, NN_1 and SS_1. These are placed as closely as possible to the wire drum, and form, with the stationary hollow interior core, nn_1, ss_1, a narrow annular space, the magnetic field, through which the drum *abcd*, with its surrounding wires, must be able to pass in its rotation with all possible freedom.

"Inside of the front hollow trunnion of the drum which rests in F, there passes another hollow tube, which is secured to the end face of the drum, and between which and the trunnion the ends *ee*, of the separate wire coils, are led through to the commutator, pp_1, attached to its front end.

"The two curved iron armatures, NN, and SS, terminate in flat plates, No Sm, and N_1o_1, S_1m_1, which constitute the cores of the electro-magnets, EE, E_1 E_1, and through which the armatures are rendered magnetic. These cores are united at their ends by strong soft iron connecting pieces, om and o_1m_1 which also serve the other purpose of forming the side portions of the cast iron framework of the machine. Here also the wires of the two horse-shoe-shaped electro-magnets, E and E_1 are wound in such way that the poles of the same name are opposite each other, so that all portions of the iron arch uniting each set of these poles exhibit the same kind of polarity. In this way the drum and the interior iron core are surrounded for about two-thirds of their circumference, and over their entire length, by the stationary exterior magnetic poles, NN_1 and SS_1 and a very extended magnetic field formed by this means, the intensity of which will be the greater the more powerful the induced currents developed, and, in consequence, the poles of the electro-magnets, become.

"In order to carry out the dynamo-electric principle, the coils of the two electro-magnets, EE, and E_1E_1 are connected with the commutator brushes, or the contact rollers, in such a way that the current generated by the machine traverses successively the wire surrounding the drum, the coils of the electro-magnets, and the electric lamps placed in the circuit. The two sys-

tems, the induced currents of the drum and the poles of the electro-magnets, exert, up to a certain maximum limit, a mutual strengthening action upon each other, which limit is determined by the wires upon the drum, the velocity of rotation of the latter, and the mass of iron in the cores of the electro-magnets.

"In order to drive so powerful a machine, a steam engine, or other uniform source of power will be required. As long as the circuit remains unclosed, and the two binding screws are not in metallic connection with each other, the rotation of the drum may be effected by the expenditure of sufficient force to overcome merely the friction in the journal boxes, F_1F_2. If, however, the external circuit is closed, by the introduction of an electric lamp, for instance, the induced currents will at once be developed in the drum, if but a trace of magnetism exist in the armatures, NN_1 and SS_1. These currents, by adding to the strength of the electro-magnets, exert a strengthening action upon the armatures, and thereby become themselves strengthened. The quantity of electricity generated by the machine, as well as the mechanical power expended in running it, will thus rapidly become greater, since every increase in magnetism is attended by a corresponding increase in the intensity of the current. It is for this reason that, for certain purposes, for producing a *steady* electric light, for instance, a uniform action of the driving engine is absolutely necessary; and all the motors designed to be used in driving dynamo-electric machines must, on this account, be provided with reliable regulating contrivances, in order to secure such uniformity as much as possible.

"In using the machine for the production of the electric light, it may happen that, through any external cause, impurities in the carbons, for instance, the arc becomes extinguished and the current interrupted. In such a case the consumption of power on the part of the machine suddenly falls almost to zero, and a considerable (even dangerous) increase in the velocity of rotation of the drum would be the consequence thereof, were the driving engine to continue working at the same rate without having a corresponding resistance to encounter. In order to meet any such danger Siemens and Halske have provided their machine with an automatic switch, which

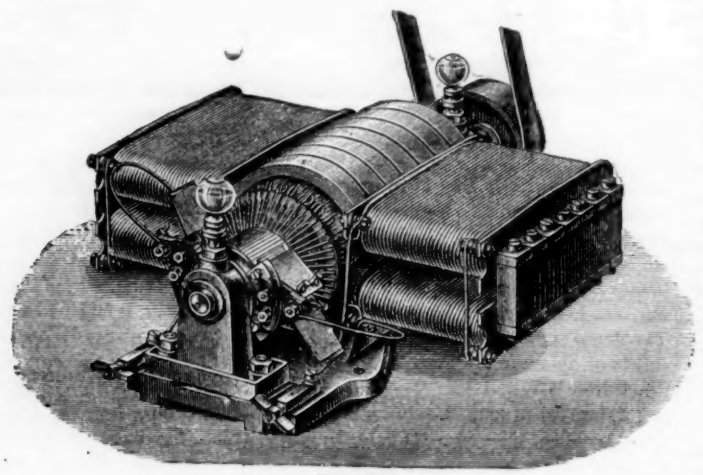

Fig. 27.

throws into the circuit an artificial resistance when, through any cause whatever, the circuit is interrupted in the lamps. * * *

"The machine represented in Figs. 25 and 26, has a length of about 10½ centimetres, a height of 32, and a width of 46½ centimetres, and yields, when the drum revolves at the rate of 450 per minute, for which six horse power are required, an electric light of 1400 standard candles. The current produced by it is capable of heating to redness a copper wire one metre long and one millimetre in thickness.

In the machines of medium and smallest size, in order to secure the necessary simplification in construction, the iron cylinder is firmly united with the wire coils, and rotates with them. The fixing of this inner armature, on the contrary, is rendered necessary in such cases in which there occurs a very frequent change of polarity, and in which the utmost utilization of the driving power is called for, which is usually only the case with the larger machines.

"Fig. 27 represents in perspective a Siemens-Halske machine (system of v. Hefner Alterneck), of the latest construction. The electro-magnets have the flat shape of those used in Wilde's machine. The current is taken off by means of metallic brushes, and the large number of radial pieces in the commutator shows that the drum carries a larger number of separate coils.

"In the latest machine of this form the commutator disc is done away with, and the ends of the separate wire coils surrounding the drum are connected with each other and led to the radial pieces of the drum shaft in a somewhat similar manner to that obtaining in the Gramme machine, which has already been described. These radial pieces are insulated from each other by means of asbestos paper. Contact rollers are no longer employed, their place being taken by flat elastic bands (brushes), made of silver-plated copper wires.

"The smaller size of these machines is 698 mm. in length, 572 mm. wide, and 233 mm. high; the drum alone is 388 mm. long, and carries 28 wire coils and a commutator divided into 56 parts. Its weight amounts to 115 kilogrammes; the maximum velocity of the drum, 900 revolutions per minute; and the intensity of the light produced, 1,400 standard candles. One and a half horse power are required to run it.

The medium size differs in construction but slightly from the one just described. It is 757 mm. in length, 700 mm. wide, and 284 mm. high; the drum has a length of 456 mm., and is also wound with 28 coils; the commutator is, therefore, also composed of 56 pieces against which wire brushes are made to press. The machine weighs 200 kilogrammes, and produces, with its maximum velocity of 700 revolutions per minute, a light of 4000 candles. It requires 3½ horse power."

[To be continued.]

[From the "Chemical News."]

The Nature of the Elements.

At a crowded meeting such as is seldom witnessed of the Royal Society, on Thursday evening, December 12th, 1878, Mr. J. Norman Lockyer, F.R.S., read a lengthy paper, in which he discussed the evidence derived from spectroscopic observation of the sun and stars and from laboratory experiments, which has led him to the conclusion that the so-called elements of the chemist are in reality compound bodies. In order that the line of argument followed by Mr. Lockyer may be understood, it will be necessary briefly to refer to the results of previous researches. As a rule, in observing spectra the substance to be examined is volatilized in a gas flame or by means of sparks from an induction coil, and the light is allowed to fall on the slit of the spectroscope; the spectrum is then generally one in which the lines run across the entire field, but by interposing a lens between the spark apparatus and the slit of the spectroscope, Mr. Lockyer was enabled to study the various regions of the heated vapor, and thus to establish the fact, already noted by some previous observers, but to which little attention has been paid, that all the lines in the spectrum of the substance volatilized did not extend to equal distances from the poles. He then showed by the aid of this method that in the case of alloys containing different proportions of two metals, if the one constituent were present in very small quantity its spectrum was reduced to its simplest form, the line or lines longest in the spectrum of the pure substances alone appearing, but that on increasing the amount of this constituent its other lines gradually appeared in the order of their lengths in the spectrum of the pure substance. Similar observations were made with compound bodies. It was also noticed that the lines furnished by a particular substance varied, not only in length and number, but also in brightness and thickness according to the relative amount present. Armed with these facts and with the object of ultimately ascertaining more definitely than has hitherto been possible which of the elements are present in the sun, Mr. Lockyer about four years ago commenced the preparation of a map of a particular region of the spectra of the metallic elements for comparison with the map of the same region of the solar spectrum. For this purpose about 2000 photographs of spectra of all the various metallic elements have been taken, and, in addition, more than 100,000 eye observations have been made. As it is almost impossible to obtain pure substances, the photographs have been carefully compared in order to eliminate the lines due to impurities; the absence of a particular element as impurity being regarded as proved if its longest and strongest line was absent from the photograph of the element under examination. The result of all this labor, Mr. Lockyer states, is to show that the hypothesis that identical lines in different spectra are due to impurities is not sufficient, for he finds short line coincidences between the spectra of many metals in which the freedom from mutual impurity has been demonstrated by the absence of the longest lines. He then adds that five years ago he pointed out that there are many facts and many trains of thought suggested by solar and stellar physics which point to another hypothesis—namely, that the elements themselves, or, at all events, some of them, are compound bodies. Thus it would appear that the hotter a star the more simple is its spectrum; for the brightest, and therefore probably the hottest stars, such as Sirius, furnish spectra showing only very thick hydrogen lines and a few very thin metallic lines, characteristic of elements of low atomic weight; while the cooler stars, such as our sun, are shown by their spectra to contain a much larger number of metallic elements than stars such as Sirius, but no non-

metallic elements; and the coolest stars furnish fluted band spectra characteristic of compounds of metallic with non-metallic elements and of non-metallic elements. These facts appear to meet with a simple explanation if it be supposed that as the temperature increases the compounds are first broken up into their constituent "elements," and that these "elements" then undergo dissociation or decomposition into "elements" of lower atomic weight. Mr. Lockyer next considers what will be the difference in the spectroscopic phenomena, supposing that A considers B as an impurity and as a constituent. In both cases A will have a spectrum of his own. B, however, if present as an impurity, will merely add its lines according to the amount present, as we have above explained; whereas, if a constituent of A, it will add its lines according to the extent to which A is decomposed and B is set at liberty. So that as the temperature increases the spectrum of A will fade if A be a compound body, whereas it will not fade if A be a true element. Moreover, if A be a compound body, the longest lines at one temperature will not be the longest at another.

The paper chiefly deals with a discussion from this point of view of the spectra of calcium, iron, hydrogen, and lithium, as observed at various temperatures; and it is shown that precisely the kind of change which is to be expected on the hypothesis of the non-elementary character of the elements has been found to take place. Thus, each of the salts of calcium, so long as the temperature is below a certain point, has a definite spectrum of its own, but as the temperature is raised the spectrum of the salt gradually dies out, and very fine lines, due to the metal, appear in the blue and voilet portions of the spectrum. At the temperature of the electric arc the line in the blue is of great intensity, the violet H and K lines, as they are called, being still thin; in the sun the H and K lines are very thick, and the blue is of less intensity than either, and much thinner than in the arc. Lastly, Dr. Huggin's magnificent star photographs show that both the H and K are present in the spectrum of *a* Aquilæ, the latter being, however, only about half the breadth of the former; but that in the spectrum of *a* Lyræ and Sirius only the H line of calcium is present. Similar evidence that these different lines may represent different substances appears to be afforded by Prof. Young's spectroscopic observations of solar storms, he having seen the H line injected in the chromosphere 75 times, the K line 50 times; but the blue line, which is the all-important line of calcium at the arc-temperature, was only injected thrice. In the spectrum of iron, two sets of three lines occur in the region between H and G which are highly characteristic of this metal. On comparing photographs of the solar spectrum and of the spark taken between the poles of iron, the relative intensity of these triplets is seen to be absolutely reversed; the lines barely visible in the spark photograph being among the most prominent in that of the solar spectrum, while the triplet, which is prominent in the spark photograph, is represented by lines not half so thick in the solar spectrum. Prof. Young has observed during solar storms two very faint lines in the iron spectrum near G injected 30 times into the chromosphere, while one of the lines of the triplet was only injected twice. These facts, Mr. Lockyer contends, at once meet with a simple explanation, if it be admitted that the lines are produced by the vibration of several distinct molecules.

The lithium spectrum exhibits a series of changes with a rise of temperature precisely analogous to those observed in the case of calcium. In discussing the hydrogen spectrum, Mr. Lockyer adduces a number of most important and interesting facts and speculations. It is pointed out that the most refrangible line of hydrogen in the solar spectrum, *h*, is only seen in laboratory experiments when a very high temperature is employed; and that it was absent from the solar protuberances during the eclipse of 1875, although the other lines of hydrogen were photographed. The line, also, is coincident with the strongest line of indium, as already recorded by Thalen, and may be photographed by volatillizing indium in the electric arc, whereas palladium, charged with hydrogen, furnishes a photograph in which none of the hydrogen lines are visible. By employing a very feeble spark at a very low pressure, the F line of hydrogen in the green is obtained without the blue and red lines which are seen when a stronger spark is used, so that alterations undoubtedly take place in the spectrum of hydrogen similar to those observed in the case of calcium. In concluding this portion of his paper Mr. Lockyer states that he has obtained evidence leading to the conclusion that the substance giving the non-reversed line in the chromosphere, which has been termed *helium*, and not previously identified with any known form of matter, and also the substance giving the 1474 or coronal line, are really other forms of hydrogen, the one more simple than that which gives the *h* line alone, the other more complex than that which gives the F line alone.

There can be no question that the facts brought forward by Mr. Lockyer are of the highest importance and value, and that they will have much influence on the further development of spectrum analysis, to which he has already so largely contributed. But his arguments are of a character so totally different from those ordinarily dealt with by chemists that they will hesitate for the present to regard them as proof of the decomposition of the elements until either they are assured by competent phyicists that they cannot be explained by any other equally simple and probable hypothesis, or until what Mr. Lockyer has foreshadowed as taking place to such an extent in other worlds has been realized beyond question or cavil in our own laboratories. It has been suggested that the same molecule may be capable of vibrating in different ways at different temperatures, and thus of yielding different spectra, just as a bell may give out different notes when struck in different ways; and although Mr. Lockyer has replied to this objection, it can scarcely be regarded as finally disposed of. The fact, however, as Mr. Lockyer has pointed out, that the change from the spectrum of a compound to the lowest temperature spectrum of its metallic element is of a similar character to, and even less in degree than, the change from the lowest temperature spectrum of the metal to the spectra which it furnishes at higher temperatures does not appear to favor such a hypothesis, and from the similarity in the phenomena it is difficult to deny that in both cases decomposition does not equally take place. Prof. Young's observations on the injection of particular lines into the chromosphere during solar storms are also difficult to reconcile with this view, and if the conclusions drawn from previous researches are correct, it also does not account for the short line coincidences which led Mr. Lockyer to his hypothesis.

Chemists are careful to teach that what are at present regarded as elements are not necessarily simple bodies, but merely substances which they are unable to decompose, or which they have no special reason to regard as compound bodies. The remarkable relations, both in atomic weight and properties, existing between many of the elements tend, indeed, to show that they are related in the manner Mr. Lockyer supposes. We sincerely hope he will continue his researches in this direction, and we trust that at no very distant time he may be able to bring forward evidence sufficiently clear to convince even the most sceptical.

Cost of Lighting by Electric Machines as Compared with Gas.

A Paper Read by Wm. Tarbell Before the New England Gas Club, December, 1878.

Gentlemen:—I have hastily brought together what few facts I have been able to learn in regard to this subject since its introduction into one of the mills of the Boston Manufacturing Co. some six weeks ago.

At present but one room is lighted by it, the dimensions of the room being some 90 × 150 feet, and the light is seen there under the most favorable circumstances—the room being very open, occupied mostly by the tables used for sorting the work manufactured in this department.

What machinery there is in the room is arranged along one side and end, and this part is lighted by gas—twenty or twenty-five burners being in use.

Two electric machines, of the Wallace-Farmer pattern, are employed to give a sufficient current to supply ten lamps, there being five attached to each machine on one circuit of wire.

The lamps consist of the glass globes, heavily ground, suspended from the ceiling, and containing the frame for the support of the carbons, armatures, etc.

At first globes only partially ground were used, but these have been removed and the heavier ground glass substituted, as with these the constant jumping of the light is less noticeable.

The carbons used are in the form of cakes, being some 2 inches wide; and it is claimed that a set for one lamp will last 13 hours, at a cost of two cents per hour.

Before making any comparisons as to cost, it is necessary to know something of the premises and the location of the light. The whole of the mill proper is divided into sections, known as "Old Mill," "New Mill," "1873 Mill," etc., which represent the various additions that have been made to the original mill, and each of which has its separate gas meter.

The electric machines are located in the upper room of the 1873 mill—"the Hosiery," so called, and as there is but one meter for this whole mill or section, I have estimated the amount of gas consumed in this room as one-third of the whole consumption of this mill or section, and this I think a very fair estimate, although, in the statement of the cost of lighting the whole mill proper, we get a better idea of the actual cost of the two methods of lighting.

Here, then, in the hosiery, are placed the two machines supplying this room with light by means of the ten lamps, and these take the place of only 120 gas burners—20 or 25 being still in use.

The power necessary to run these is estimated at 20-horse, 10 for each machine. This I think very low.

The actual cost of gas for this mill or section for one year, at $2.80 per thousand feet, was $1,022, and for the hosiery room, which I have taken as one-third the whole, the cost would be $344.

I think it is fair to say that artificial light is needed in the mill on an average for two hours per day—250 days in the year. This, reduced to full days of ten hours each, gives 50 days of lighting.

Taking the cost of one-horse power a year at $50, the cost of power necessary to run the two machines would be $166.60.

The cost of carbons for the ten lamps, for 500 hours each, at 2 cents per hour, would be $100.

To this must be added the cost of using the 20 gas burners still in use, which is, say, $50.

The cost of each electric machine, including lamps, wires, etc., is $1,500; and adding ten per cent. on the $3,000, or cost of the two machines, as interest, wear, etc., we have the following as a result of our estimates:

10 per cent. on machinery	$300 00
20-horse power, per year	166 60
Carbons consumed per year	100 00
20 gas burners still in use	50 00
Making a total of	$616 60

against the estimate of $344, the cost of gas for the same room, and by which it was amply lighted.

This gives us a balance in favor of gas for this room alone of $272.60, and this is without allowing for attendance of the machines, lamps, etc., which could not be reckoned less than $50 per year.

Taking these figures as a basis, let us compare the cost of lighting the whole mill, or all the different sections combined.

The cost of gas for one year was $2,857.68, and it is safe to say that it would require 15 or 20 of the 5-light electric machines to light the same area—say 15; then we have a result as follows:

Cost of power	$1,249 50
Cost of carbons	750 00
10 per cent. on machinery	2,250 00
Attendance—say	1,000 00
Making a total of	$5,249 50
Against the cost of gas	2,857 68

In the estimate of lighting the hosiery I did not make any allowance for attendance, but if it was introduced into the whole mill I should judge that one man, at least, would be required constantly.

Another interesting fact to notice is the enormous amount of light which seems to be wasted. It is claimed that each electric candle gives a light equal to 1,000 candle power, or 10,000 for the two machines, while the 120 gas burners which it replaces would give a light equal to 1,900 candle power at least, and this was sufficient to light the room in every part.

When the electric light was first introduced only one machine was used; but the five lamps, although giving a light of 500-candle power—more than double that of the gas-light—was insufficient to light the room.

Even now, with two machines, as stated above, a number of gas jets are in use, to displace which at least two more lamps would be required, and it is very doubtful whether these could be attached to the machines now in use without considerable diminution in the lights.

Reduction in Price of Gas in Wilmington, Del.—The Wilmington Coal Gas Co. have reduced the price of gas from $2.25 to $2 per thousand net, to take effect on and after the 1st of the present month. The action of the directors in this instance goes to show that gas can be manufactured and sold even in small towns, at a moderate price, and still pay good dividends.

[From London "Journal of Gas Lighting."]

West of Scotland Gas Managers' Association.

[Continued from Page 12.]

Mr. Mitchell (Coatbridge)—I have great pleasure in proposing that we accord to Mr. Stewart a hearty vote of thanks for the able address to which we have just listened. The President has taken up and dealt, in his usual vigorous manner, with several questions of very great interest to gas managers, not the least prominent of which is that of electric lighting. The subject is one that has interest to most of us, and it is one that deserves our serious consideration. I am sure you will agree with me in awarding to Mr. Stewart our best thanks.

Notes on Some of the Physico-Chemical Laws Relating to Gas.

Mr. Wm. Young (Clippens), who was received with loud applause, said:

Since joining this Association and coming into intimate contact with its members, I have been quite surprised, and at the same time much gratified, to observe the anxiety displayed by its members to become better acquainted not only with the merely mechanical details of their profession, but also to acquire a knowledge of the physical and chemical laws upon which their manufacturing process is based. And I am the more especially pleased to see this trait in the character of its members, as I am sure that it is only by the acquirement of such knowledge that the manufacture of gas can be brought to its utmost state of perfection, and able to compete with other modes of illumination. The old "rule of thumb" mode of manufacture will no longer be tolerated, and it will be those among us who have made the profession a science who will succeed in the battle of life.

During the past twelve months, partly on account of ill health, and partly from having extra duties to perform, I have not been able to do much practical experimenting on the manufacture of gas, and consequently have nothing of a very practical turn to bring before you to-day; but although the hands have not been able to work, the mind, somehow or other, has had time to think. Those thoughts I have noted down from time to time, and as they have a physico-chemical bearing upon your manufacture—more especially directed to the explanation of certain well-observed results from a reference to ascertained laws of nature—I thought, from what I have already indicated, that they might prove acceptable to the members of this Association.

I regret that I have been unable to extend these notes in writing, as I would have liked; but I shall do what I can, in an extempore manner, to render them intelligible.

Grafton, in his experiments relating to the cause of carbon deposit, states that he observed, as I have no doubt you have all, more or less, observed, that as the film of carbon on the internal surface of the retort gains in thickness, the more rapidly does it go on accumulating. You are also all aware that on new retorts there is a greater tendency to deposit of carbon than on old ones, and, if I remember aright, our worthy member, Mr. M'Gilchrist, of Dumbarton, has stated that he counteracts this tendency in new retorts by careful scraping of the internal surface, and that after a period of time the retort so regularly scraped gradually loses, to a large extent, the tendency to acquire a deposit of carbon.

I can verify the last statement of Mr. M'Gilchrist, as I have frequently visited his works, and paid particular attention to the state of his retorts.

The question then arose in my mind: How do those results come about? At first I attributed them solely to the roughness of the surface of the new retorts, and to the increase of surface by the increased deposit of carbon as it accumulated in the retorts; but some experiments which I have made lately convinced me that they were due to another cause. Those experiments I shall repeat to you to-day, and I hope they will at least point to a different cause, and lead some of our members, who are fortunate enough to have more time to spare than I have, to more fully investigate the subject.

Before proceeding, however, to make those experiments, permit me to allude to a letter from Mr. Joseph Tysoe, which appeared in the columns of the *Journal of Gas-Lighting* some considerable time ago, in which he drew attention to the diffusion of gases, or, as he put it, the dialysis of gases, having the effect of causing the carbon to deposit on the surface of the retort. This, in so far as I am aware, was the first occasion upon which attention had been drawn to the diffusion of gases as affecting the deposit of carbon. At the date of this letter I was not of opinion that the diffusive action was the cause, and expressed my opinion to that effect in a letter to the *Journal* at that time. Now, however, I entertain a different opinion, for although the tendency of gaseous diffusion does not in all respects act in the manner indicated by Mr. Tysoe, yet I believe that the tendency of gases to diffuse through each other, combined with the condensing power of carbon on gases, is the principal cause of the results referred to.

I have here an arrangement to illustrate the diffusive action of gases through porous septa. It consists of a porous earthenware vessel, such as is used in the carbon voltaic battery of Bunsen. I shall ask you to suppose that this represents a gas retort. You will observe that this cell is cemented into this basin, and that it has attached to it this glass tube about a yard in length, which dips into this jar of water, colored to render visible its rise and fall in the tube.

By means of these two pipes I will fill the porous vessel with the coal gas supplied to this room. You wil observe that the moment I cut off the supply by turning the taps on the outlet and inlet pipes, the colored water in the glass tube rapidly rises, showing that there is a partial vacuum formed inside the porous cell. Now, how is this partial vacuum brought about? It is because the coal gases tend to diffuse through the air external to the porous vessel, but as coal gases possess a higher diffusive rate—or, in other words, as the molecular motion of the coal gas is greater than that of the external air, the coal gas passes through the pores of the clay vessel more quickly than the air passes inward, the water rising in the tube to supply the difference in the rate. For a few minutes I shall again pass a current of coal gas through the retort or porous cell, but this time I shall keep it covered with this glass bell-jar. During the time the gas has been passing through the cell it has been diffusing through its pores into the space between the cell and the bell-jar, and at the same time the air in the space has been passing through the pores into the vessel. By now shutting off the current of gas you observe that the colored water in the glass tube rises very slowly, and only to the extent of a few inches, and then slowly falls till it reaches the level of the water in the jar. This results from the fact that the gases outside and those inside the cell have a like composition, and that although the diffusion or passage of the gases through the pores of the cell is still going on, yet the rates at which they are passing are the same, and therefore there is no vacuum formed; but if I now slowly lift the glass bell-jar, and thereby remove the external atmosphere of coal gas, you see that the rate of the diffusion is disturbed, the coal gas passing outward from the cell much more quickly than the air does inward through the cell, the water in the tube rising rapidly to supply the deficiency. If I now lower the bell jar, and thereby bring back the atmosphere of gas, which from its lower specific gravity to a certain extent remains behind in the bell-jar, the rate of diffusion is again altered, and the colored water depressed, as the rate of diffusion inward is greater than that of the mixed gas and air outward.

Now, as you are aware, coal gas is a heterogeneous mixture of various gases, each of which diffuses at different rates; and further, the rate of diffusion of each of the gases or vapors is more or less modified

by that of its neighbor; but, roughly speaking, each gas or vapor diffuses in a ratio dependent upon the square root of its density, the lightest having the highest diffusive rate.

The coal gas which we have been using has a specific gravity, in all likelihood, about half that of air; but hydrogen, even when saturated with moisture, has a specific gravity about 1-14th that of the air. I shall now repeat my experiments with the latter gas, upon which you will observe that all the former results are intensified.

After filling the cell with hydrogen gas, and suddely cutting off the supply, you see how rapidly the colored water rises in the tube—so rapidly, indeed, that it would go up into the porous cell and destroy its porosity, were I not to open this tap, and thereby allow a quantity of air to pass in, sufficient to make up the difference in the rate of diffusion of the hydrogen out through the pores of the cell to that of the air inward.

I will now repeat the experiment by covering the bell-jar. You observe that, after streaming the hydrogen through the cell for a minute, and then cutting off the supply, the water in the tube now rises comparatively slowly and only to a limited height, due to the atmosphere both inside and outside the cell having nearly the same specific gravity, and consequently similar molecular motions; but the moment I commence to lift the bell-jar, and thereby, so to speak, lift the hydrogen atmosphere from outside the cell, and allow access to the denser air, that moment the water rises in the tube, showing that the hydrogen in the cell diffuses outward more rapidly than does the air inward. By returning the bell-jar, and consequently the atmosphere of hydrogen, the colored water sinks; and, by moving the bell jar slowly off and on to the cell, the rate of diffusion is alternately altered, and the colored water rises and sinks as if by magic.

Now, gentlemen, we have in these experiments been dealing with gases in the cold, and with a perfectly porous septum, and, although they may explain why new retorts gather carbon more quickly than old ones, they give no explanation of the other observed results—viz., that by allowing the carbons to go on accumulating, it grows the faster, and that by scraping the internal surface of the retort, the deposit is prevented.

The explanation of these results is to be found in the fact that, in the practical carbonization of coal, the gases and vapors do not pass as simple gases and vapors through the porous wall of the retort, but that they undergo decomposition, and thereby acquire new diffusive rates in their passage.

To illustrate: Let us take benzole as the hydrocarbon which we wish to follow in its passage through the wall of the retort on the inner side, as C_6H_6, and in all likelihood the portion reaching the other side will do so as nearly pure hydrogen, the carbon having been left behind; but the decomposition will be progressive the greater portion of the carbon being left behind on the inner surface. Thus two molecules of benzole enter as $C_{12}H_{12}$, but before they penetrate an inch in depth, they may be decomposed, stage by stage, into three molecules of marsh gas, 3 $CH_4 = C_3H_{12}$, leaving behind nine atoms of carbon; and, as the marsh gas has only a specific gravity of 0·559, its rate of diffusion will be much greater than that of benzole vapor, having a specific gravity of from 2·738 from which it was produced, and, therefore, a portion will have a tendency, from its higher molecular motion, or diffused rate, to return to the retort from which it came. The remaining half, say, passes outward, undergoing further decomposition, leaving the carbon behind, and becoming pure hydrogen. At the same time, a portion of the furnace gases will pass into the retort, the quantity being dependent upon the specific gravity—that is, supposing the wall of the retort is porous; but we know that in actual practice the walls of the retort do not long remain porous, because the furnace gases carry with them portions of ash and the alkalies present in the ash, which form a flux on the surface of the retort, and, so to speak, glaze and destroy its porosity. Supposing such should be the case, it does not follow, however, that the diffusion of the gases would cease, and that the carbon would stop being deposited, because the hydrogen which would be produced from the decomposition of the marsh gas in the external pores of the retort, would, from its high diffusive rate or molecular motion, return to the retort from which it came.

Thus, we see, it is not necessary that the diffusion should extend through the wall of the porous vessel, as when both septa and gas are cold, but that when the decomposition takes place in the walls of the porous vessel, and the specific gravity of the gases is thereby altered, the diffusion may take place in the pores of the vessel itself.

I have here a diffusometer, formed of two porous cells and an external glass one, a thin concentric film or space being left between each. Connected to each space is a tube similar to that attached to the diffusometer already experimented with. By a suitable pipe I am able to supply the inner cells and spaces with such gases or vapors as would likely be present in the walls of the retort when heated, and when the products of distillation of the coal are undergoing distillation. By this arrangement, the diffusive action of the gases can be beautifully illustrated in the manner referred to; but the time necessary to perform the experiments is such as to prevent me from making them before you to-day.

The President—There is plenty of time, Mr. Young.

Mr. Young—The rest of my paper will take up a considerable amount of time, and I am anxious to get through the whole of my notes, though it may be superficially. At some of our future meetings I propose, if I am able, to bring the matter forward in a more perfect form, when the members will be better able to discuss the question. My object just now is to give a cursory narration of what I have been thinking about, so that members may be able to experiment practically upon the subject, and at a future meeting take up and discuss the matter. I may further state that my health has been by no means what it should have been, and I am even now suffering from headache, and therefore hope to be, at present at least, excused from making the experiments.

The President—I am sure we all sympathize with you; but it would be a great loss not to learn more on this interesting subject.

Mr. Young—Perhaps I may be able to make it a little fuller in extending my notes for publication. In the meantime, returning from this digression, let us examine what would be the effect of scraping away the carbon from the inner surface of the clay as it is formed, or, at least, leaving as thin a film of carbon as possible on the internal surface of the retort and, on the other hand, allowing the carbon to deposit at its own free will.

I have here two diffusometers, formed of discs of carbon attached by cement to two glass tubes—the one from a retort in which the carbon has been allowed to collect freely, and the other from one where it has been kept thin by regular scraping. I will fill each of these diffusometers with hydrogen, and place them in their respective jars of colored water. You will observe that the one formed of the carbon which has been regularly scraped shows no indication of the diffusion through it of hydrogen, while the other allows the hydrogen to diffuse rapidly, shown by the colored water rising rapidly in the tube. The reason of these results will, I have no doubt, have already suggested itself to your minds—viz., that by continual scraping of the surface of the carbon, it ultimately, from the carbon deposited within its pores, becomes so dense as to be non-porous, and perfectly impervious to the products of distillation; and, therefore, the only carbon deposited is that due to the contact of the gases on the highly-heated surface, and as that surface is smooth, the deposit is small; whereas, on the other hand, the newly-deposited carbon, when unscraped, is porous, and acts as an excellent diffusometer or atomalyzer. The gases and vapors enter its pores freely, there undergoing decomposition, carbon being deposited, and the liberated hydrogen, marsh gas, and other gases having a low specific gravity, returned into the retort. Porous carbon, as you are also aware, has the power of condensing vapors and gases with its pores; and as its unscraped surface is rough, it rapidly gathers fresh coatings of carbon.

From the foregoing, it will be readily understood how carbon can collect on iron retorts, it being only necessary that a thin film be deposited, which will be produced by the contact of the vapors of distillation with the highly heated iron. This will at once become an atomolyzer of the gases, and as the carbon gradually increases in thickness the more will the diffusion of gases come into play, and the more quickly will the carbon be deposited.

My next note bears upon the observed fact that light charges of coal give much better results, quantity and quality of gas considered than heavy charges. For instance, a retort capable of containing 3 cwts. of coal at a charge, gives, when charged with 2 cwts., better results than when charged with 3 cwts.; but where 2 cwts. of coal are charged into a retort capable of holding that quantity only, it does not give better results than the 3 cwts. charged into the 3 cwt. retort; but 1½ cwts. charged into the 2 cwt. retort give results equal to the 2 cwt. charge in the 3 cwt. retort; or, in other words, when coal is charged into a retort to completely fill it, not so good results are obtained as when the quantity of coal charged into the retort is such as to leave a considerable free space above it.

It has hitherto been supposed that those results were due to the increased surface in proportion to the smaller charge, as well as to the gas escaping more freely from the retort, by reason of the space above the charge. There is no doubt that the results are in part due to these conditions, more particularly with English caking coal; but I do not think they are wholly due to these conditions, for were these conditions the sole cause, then, with surface and charge proportionate to each other, whether a space were left or not, like results would be obtained when shales, parrots, and non-caking splints were used, where there is always ample space between the pieces for the escape of the gases from the retort to the standpipe. From practical experiment I know that such is not the case. As large a yield may be obtained, but the quality is defective. Further, in the destructive distillation of shale for oil, we have another proof that the free space above the charge alters the nature of the distillation, for a horizontal retort, where there is a free space above the charge, gives 10 to 20 per cent. less oil than is got from a vertical retort, when the charge completely fills it, the volatile products finding their way from the retort through the spaces between the shale. The oil also, from the horizontal retort, has a much lower specific gravity, containing fewer of the higher solid paraffines, showing that the products of distillation have undergone a different kind of distillation from that in the retort where the shale filled it completely.

From a recent study of some of Professor Tyndall's works, I have come to the conclusion that the results referred to are, to a large extent, due to the action of radiant heat.

But, before proceeding further in this matter it is, perhaps, necessary that I should make a few preliminary remarks upon the modern theory of heat, in so far as it has reference to my subject.

Heat, according to modern ideas, is a mode of motion—that is, it is a state of matter, not a substance. Just as sound is a state of motion of matter made sensible to us, as sound, through the motion having been communicated to the air in a series of pulsations or waves, and those waves striking upon the diaphragm of the ear; so is heat supposed to be a mode of motion of the molecules of matter, this motion being made sensible to us as radiant heat by the moving

molecules communicating their motion to an ether which pervades all space.

The motion of matter which produces by radiation through the air the sense of sound, can also be felt. If the hand be laid on a large bell, whilst sounding, you feel the tremor or motion of the mass, or if I strike this tuning-fork, and cause it to vibrate, on bringing it cautiously into contact with any part of my skin, I feel that it is vibrating.

In a similar way, the molecular motion which, by radiation through the ether, produces the sense of heat, can also be felt, for on laying the hand on a heated mass of metal we experience the motion of the molecules as heat.

By this resemblance between sound and heat, I will now endeavor to convey to your minds how it is that radiant heat affects the carbonization of coal.

I have no doubt but most of you will have made the experiment of opening the cover of a piano, and singing into the wires. When you did so, you would find that, just as your voice rose and fell, certain of the wires would be set in motion; or, in other words, that the wires would respond to the voice. I propose to further illustrate this part of my subject by means of those tuning-forks; but the noise from the street is so great that it would completely drown the sound of the forks. However, after the meeting is past, you may experiment for yourselves, when by bringing them close to you, and sounding this fork, and presenting it to each of the other forks in succession, you will find that only one of these will respond and take up the sound.

Now, why is this the case? As I believe most of you are aware, when you sing to the piano you, by means of the larynx, mould the air as it passes from your lungs into a series of waves or pulsations, which, striking upon the strings, set in motion the wire, which would, from its length, vibrate synchronously with these vibrations.

In the same way the tuning-fork set in motion moulds the air into a series of waves, and it is only the tuning-fork of the set which can move synchronously with those waves which can respond.

I have here an ivory ball suspended by this piece of string. By a series of puffs from my mouth, timed to synchronize with the rate at which the suspended ball can oscillate as a pendulum, I gradually set it swinging, each puff augmenting its motion. If I now lengthen the string, and make a series of puffs at the same rate as before, the ball does not move, but remains stationary. Why? Because the rate at which the ball can swing, due to its weight and the length of the string, no longer synchronizes with the puffs; but if I slacken the rate of puffs of air till they are timed with the swing of the ball, it at once begins to swing.

It is supposed that were heat absent from the earth the molecules of all matter would be stationary; but heat being present, all molecules are in motion. Now, like the wires of the piano, the tuning-fork and the swinging ball, Tyndall has shown that the molecules of gases and vapors have different rates of motion peculiar to themselves, and can only respond to the waves of the other radiating from the molecules of a heated body which synchronize with their own rate of motion.

On gradually heating a platinum wire by sending a current of electricity through it, is found that the first waves of ether radiating from it are the longest, and that as the heat gradually increases there are added shorter and shorter waves, till on the platinum attaining its point of fusion these waves are of a great variety of lengths, the radiation corresponding to a diapason of sound.

Tyndall found that when a ray of radiant heat was passed through the simple gases, hydrogen, oxygen, nitrogen, etc., substantially no absorption takes place; or, in other words, no increased motion was imparted to the molecules, because their motion was much greater than any of the waves of ether; but when the simple gases were made to combine, the motion of the molecules was lowered to a large extent; and, as a general rule, that the more complex the compound formed, the greater was the reduction of the molecules' motion, and the higher was the rate of absorption of a ray of heat sent through the vapors of the complex substance.

The following table gives the results of some of Tyndall's experiments on radiant heat at various temperatures:—

Table of Absorption of Heat by Vapors at a Pressure of 0·5 of an inch of Mercury.

Name of Vapor.	Formula.	Atoms in Molecules.	Source of Heat, Platinum Wire. Barely Visible.	Bright Red.	White Hot.	Near Fusion.
Bisulphide of carbon	CS_2	3	6·5	4·7	2·9	2·5
Chloroform	$CHCl_3$	5	9·1	6·3	5·6	3·9
Iodide of methyl	CH_3I	5	12·5	9·6	7·8	—
Iodide of ethyl	C_2H_5I	8	21·0	17·7	12·8	—
Benzol	C_6H_6	12	26·3	20·6	16·5	—
Amylene	C_5H_{10}	15	35·8	27·5	22·7	23·7
Sulphuric ether	$C_4H_{10}O$	15	43·4	31·4	25·9	21·3
Formic ether	$C_2H_6O_2$	11	45·2	31·9	25·1	—
Acetic ether	$C_4H_8O_2$	14	49·6	34·6	27·2	—

You will observe that as the number of the atoms constituting a molecule become more numerous, the greater is the rate of absorbtion, except in the case where the atoms of oxygen are introduced, which appears to have a greater power of lowering the rate of motion of the molecules, and consequently heightening the rate of absorption, this being due to the greater complexity of the molecules.

Let us now examine heat transmitted by contact, in which the ether takes no part. If I sound this tuning-fork, and bring it close to the other forks, only one of them, as you are aware, is capable of responding to the moulded pulsations of air sent from the tuning-fork, but if I cause the prongs of the sounding fork to touch any of the other forks, it can cause any of them to sound. If I present the tuning-fork to the strings of the piano, taking care that is does not touch them, only those strings can respone of which the rate of vibration synchronizes with the waves or pulsations of air passing from the tuning-fork; but if I cause the vibrating prongs to touch the wires, it can set any of them in motion.

In the same way the heated molecules of a substance which radiates ether waves, though quite incapable, through the medium of the ether, of increasing the molecular motion of the molecules of the simple gases, yet when the gaseous molecules are brought into contact with the heated molecules of the substance which radiates the heated wave, the gaseous molecules are at once heated, the clashing molecules striking against each other, communicating the motion to each other in the same way as the moving prongs of our tuning-fork can that of another when they are brought into actual contact.

We have seen that radiant heat has, so to speak, a selective power; that in a mixture of gases and vapors the molecules of the most complex are capable of absorbing the greatest quantity of the ether waves of radiant heat, and the simpler molecules are comparatively inert in the presence of radiant heat.

In the free space above the charge in a retort, the volatile products of distillation are subjected to the action of radient heat. Those products, as you are aware, are very complex mixtures; some of them, such as the lower members of the olefiant gas, paraffin, and benzole series, which are comparatively simpler bodies, and which are gaseous at ordinary temperatures, it is not desirable to further decompose. These, in consequence of their molecules not having the property of responding to the radiant ether waves radiating from the walls of the heated retort, pass on undecomposed. There are, however, other products of distillation which, if allowed to escape, would condense as tar, and it is therefore desireble to further decompose them, because the products of their decomposition are valuable gaseous illuminants. Now, the radiant heat, although inert, in so far as the simpler compounds are concerned, is not so in the case of those complex compounds, some of which, such as the higher paraffins, contain upward of fifty atoms in their molecules.

Those complex molecules respond to the ether wave of radiant heat from the walls of the retort, or, so to speak, absorb them; their motion being thereby so accelerated that they are shaken to pieces, or decomposed into simpler compounds. Whereas, when the retort is full charged, and no free space is allowed, the decomposition must be brought about almost by contact between the heated molecules and the molecules of the gases and vapors.

We have seen that when decomposition is so brought about, it is not, so to speak, selective, as when radiant heat is employed decomposing those vapors which it is desirable should be decomposed, and allowing those to escape which it is desirable should not be decomposed; but that all are alike heated and decomposed, and therefore an inferior quality of gas is produced.

I hope that what I have said is sufficient to show how heat, by being differently applied, may bring about very different results; and how it is that the free space left over the charge of coal in the retort leads to better results being obtained.

[To be continued.]

The Effects of Gas on Leather Bookbindings.

One of the many reasons for looking with favor upon the introduction of the electric light, is the belief that it will have no injurious effects on pictures, frames and bookbindings. Gas has always been supposed to destroy book leather; but, in a recent letter to an American contemporary, Prof. Wolcott Gibbs, of Harvard University, United States, says:—"Some time since I made an examination of the binding of books in the Public Library, supposed to be injured by the products of the combustion of coal gas. I arrived at the conclusion that there was not sufficient evidence to show that such was the case. I have since made a careful examination of books in the Athenæum College, and Astor Libraries, and have found precisely the same state of things. You are aware that gas has never been used in the College and Astor Libraries at all, and that in that of the Boston Athenæum gas is largely used in the reading room but not in the library proper. I found in each a large number of old books bound in calf, which presented the same appearance as those which I saw at the Public Library. These were all old books, and all bound in calf. Mr. Wilson, binder to Little and Brown, and a man of large experience, told me that the trouble was in the tanning of the leather and not in the action of the gas, the older kinds of leather used by binders being of poor quality and badly tanned. I analysed a number of samples of the leather in my laboratory, and find no free acid whatever. On the whole, therefore, I see no reason to change my opinion in the matter."—*Iron.*

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THURSDAY, JANUARY 16, 1879.

Official Report of Examinations of Gas for two Weeks ending Jan. 11, 1879, made at the Photometrical Room of the Department of Public Works.

Corrected Illuminating Power.

Dec. 1788.	Time of Day at which Test were made.	New York Gas Light Co.	Manhattan Gas-Light Co.	Mutual Gas-Light Co.	Metropolitan Gas-Light Co.	Harlem Gas-Light Co.	Municipal Gas-Light Co.
30	Between 9.30 A.M. and 1 P.M.	15.17	15.43	17.81	16.40	16.06	
31		15.42	15.34	17.45	16.74	16.66	
1879. Jan. 2		16.20	15.53	18.41	16.85	16.52	
3		15.05	15.40	17.41	17.01	16.49	
4		16.12	15.28	18.55	16.50	16.11	
	Average	15.59	15.39	17.92	16.70	16.36	
6		17.32	16.53	18.36	16.42	16.34	
7		17.17	17.11	18.42	16.52	16.87	
8		17.26	16.91	18.24	16.82	16.02	
9		16.93	16.27	17.96	16.60	16.18	
10		16.91	16.70	18.16	16.51	16.14	
11		17.33	15.96	18.89	16.48	15.28	
	Average	17.15	16.58	18.34	16.55	16.14	

Sugg-Letheby burner.

E. G. LOVE, Gas Examiner

Wood-Staining.—Wood may be stained *brown* by a concentrated aqueous solution of permanganate of potash; *red*, boil ¼ pound of logwood and ½ ounce of soda in 1 pint of water; apply it hot, and then wash it over with a strong aqueous solution of alum; *rose*, iodide of potash in 12 parts of water for a first coat, and corrosive sublimate in 40 parts of water for a second; *blue*, indigo solution, or a concentrated hot solution of blue vitriol, followed by a dip in a solution of washing soda; *yellow*, tumeric, dissolved in wood naphtha, or aqua regia in 3 parts of water; *green*, verdigris, dissolved in 4 parts of water.—*Fortsch. d. Zeit.*

Correspondence

[We are not responsible for the opinions expressed by Correspondents. Correspondents, in all cases, should sign their communications with their names and address in full—not for publiction, unless desired, but as a guarantee of good faith.—ED.]

Electric and Gas Light.

PITTSBURGH, Dec. 4, 1878.

MAJ. G. W. DRESSER:

My Dear Sir:—I brought off in my pocket for travel reading a GAS-LIGHT JOURNAL of Dec. 2, and noticed Dr. Sloane's paper. At first I thought I would reply, but a little consideration served to satisfy my mind that it would not be good newspaper matter for you, and I have concluded to ask you to send this letter to Dr. Sloane, whose first name or address does not appear in your columns.

The mistake of the article lies in "The light given by the flame is due to the ignition of particles of solid matter," and in this sentence the error is in the use of the word "iguition" for "incandescence."

The ignition of carbon is unquestionably productive of heat, as the Doctor supposes, but it is equally unquestionable that it is entirely unproductive of light. I will not here argue this point, for I think that Dr. Sloane will only need have the proposition stated to appreciate it, and that he will re-make his figures on the expenditure of heat in the production of light by incandescent carbon from some other basis of estimate. The most practical one which has presented itself to me so far is found in the mechanical equivalent of heat in the voltaic arc between carbon points, in an electric light. Of course the perfect development would involve the isolation of the carbons so that they could not "ignite," in a vacuum or in an atmosphere of CO_2. But I made a resumé of the facts, so far as common *practice* is concerned, in a communication in *Engineering* of September 11, while the corresponding data for gas lighting can be found in your pages on the "Physics of Coal Gas," (about February, 1878, I think).

If you will send me Dr. Sloane's address I will forward a pamphlet giving the data referred to commercial coal gas, somewhat more carefully estimated than he has done for his paper before the American Gas-Light Association.

As to the future of the electric light, "It is not going to be much of a shower."

Respectfully,
ROBT. BRIGGS.

ROBERT BRIGGS, C.E.:

Dear Sir:—In your criticism on the paper I read before the National Association of Gas Engineers last October, you find fault with the word "ignition," saying it was a mistake, and that I should have said "incandescence." There is no mistake whatever. The word "ignition" is always used by chemists and in chemical works in the sense I used it in. This signification is, "the act of raising a body to a high temperature." It is the reciprocal transitive of "incandescence." To "ignite to incandescence" is a correct expression.

To give a practical view of the loss of heat in the gas flame I would always use this basis of estimate—the temperature and the amount of the carbon ignited. Could we determine directly these factors in any given gas, we would have no need of photometry; the illuminating power of a gas represents their product. The electric light basis is not practical, because it is a special case, involving the consideration of the intense heat of the voltaic arc. This heat is so intense that any figures based on it would be in the highest degree impracticable ones.

We know also that as the temperature of an "ignited" body is increased, it may pass through the different phases of, 1st, obscure heat, when no light will be radiated; 2d, red heat, when of one hundred parts of heat radiated one part or less will be luminous heat; 3d, white heat, or "incandescence," when, according to the temperature, from two to ten per cent. of the heat radiated will be luminous. In an ordinary gas flame the carbon is ignited to the temperature described in the third divison, and radiates about three per cent. of luminous and ninety-seven of obscure heat. If the temperature be raised, then, without the addition of carbon, but by drawing on the waste heat of the gas flame, a better result will be obtained, because, as the heat is greater, more luminous and less obscure heat will be radiated. This is why large burners are the most econonical, and why lava tips give better results than metal ones; in the first case, in both instances, the flame is hotter.

In this JOURNAL of Jan. 2 a communication on the "Comparative Economy of Elelectric and Gas Lighting" appeared over your signature. It deals entirely with the light derived from the voltaic arc, and it is some of your statements concerning this light that, with your permission, I will criticize.

In your estimation of the relative economies of the two systems, you leave out of account the objection, now positively a hackneyed one, that the electric light is incapable of subdivision. Yet this objection is a very serious one. Let us assume four hundred candles as the illuminating power that a single voltaic arc can economically produce. An ordinary gas burner may produce one-fortieth of this amount of light; doing this it will illuminate a point at any given distance to the same degree that the forty times will at only six times (about) the distance. So that if the electric light be furnished from four hundred candle centres, or burners, each one on this basis would represent only six ten-candle gas burners, instead of forty.

One of your paragraphs says that, comparatively, "the enormous advantages of the electric light, as regards comfort, health, and safety," "are obvious." As for the "comfort" of it, let anyone visit Loeser's drygoods store in Brooklyn, and pass half an hour in the blaze of six electric burners, which illuminate the ground floor, then let him go upstairs to the upper story, illuminated by gas, and I will rest the "comfort" question on that experience.

It may be "healthy," but so is gas, if some slight ventilation is provided. If the electric light be allowed to reach too high an intensity, it may become highly injurious. "Despretz observes that too great precautions cannot be taken against the effects of the electric light when it attains a certain intensity. The light of 100 couples, he says, may produce very painful affections of the eye. With 600, a single moment's exposure to the light is sufficient to produce very violent headaches and pains in the eye, and the whole frame is affected as by a violent sunstroke."—*Ganot's Physics.*

These were observations made in the days when the battery was used for the production of the light, and do not give the result of years' constant exposure to its influence. What this might be we do not, and probably never shall, know.

It is certainly "safe," as far as fires are concerned, but not safe as regards liability to interruption, and the chance of the boiler of its steam engine exploding. But, of course, the last-named danger can be avoided by the use of a gas engine.

The next paragraph contains this assertion: "The complete absence from flickering, so objectionable in all gas-light, being but partly relieved by the argand burner, constitutes a great superiority for the electric light." I stated, it will be remembered, that in criticizing this article I would interpret it as applying only to the voltaic arc. Making this interpretation, I will assert that there never has been, and in all human probability never will be, an electric lamp constructed that will not flicker. There is only one substance known to us that possesses the properties essential to the construction of electrodes for the arcs. Those properties may be thus enunciated: the substance, 1st, must be able to withstand an enormously high temperature without melting; 2d,

it must be a conductor of electricity; 3d, it must be a non-conductor of heat. Carbon is the only substance on this earth, as far as we know, that contains these properties, and there are no grounds for believing that any other element remains hidden and undiscovered which can replace it. What other worlds contain we know not. If we consider meteorites as missives from other planets, or as actual asteroids, they afford some negative evidence that the planets do not contain any elements that mother earth does not. Carbon has been tried in every conceivable way—has been carefully purified, has been mixed with other substances—but so far no electrodes have been made of it sufficiently homogeneous to produce an even light, and the chance that they ever will be is, owing to the nature of this element, very small.

Speaking in all seriousness, the solution might be found in the use of diamonds; when we are able to manufacture these, the problem, it is quite likely, may be solved.

As for gas, any one who has photometered it, using an argand, knows how remarkably free from flickering it is. An oil lamp, much less the electric light, cannot compare with it for freedom from variations in illuminating power.

Your concluding sentence is in effect that a perfect light should be perfectly steady, and the perfectability of the electric system, and of any other, will only be *relative*. As related to gas, the perfectability of the electric light, accepting this criterion, has always been and always will be inferior.

Yours respectfully,

T. O'Conor Sloane, Ph.D.

Obituary.

Death of Mr George J. Whitney, President of the Citizens Gas-Light Company, of Rochester, New York.

Mr. George J. Whitney, President of the Citizens Gas Light Company, of Rochester, New York, died at his home, on the 31st of December, 1878, after a lingering illness of eight weeks.

Mr. Whitney was largely interested in the grain business, and probably reached a degree of distinction in that line second to that or no other man. At the time of his death he had entire charge of the transportation, storage, and delivery of all the grain carried over the New York Central and Hudson River Railroad. Under his sole control were the great elevators at Buffalo, and the gigantic structures for the storage of grain at the other end of the route in New York City.

He was never deterred by hesitation or fear from engaging in the most extensive operations; and though all his ventures were based upon the results of careful reasoning and sound judgment, they sometimes partook of a bold character. He was too firm to waver—too self-reliant to know the nature of doubt or fear.

One characteristic of Mr. Whitney, which should not be overlooked, was his solicitation for the interests of the workingmen in his employ, to whom he was ever generous and considerate.

Beside being President of the Citizens Gas Company, Mr. Whitney was a Director of the New York Central and Hudson River Railroad, a director of the board of management of the Rochester Savings Bank, of the Rochester Driving Park, the Rochester City Hospital, and President of the Board of Trustees of the Western House of Refuge, and of various other organizations and institutions.

George J. Whitney was a man who enjoyed the respect and esteem of all who knew him, and one whose taking off cannot but cause a void within a large circle, and render the community sensible of the loss it has sustained.

At a special meeting of the directors of the Citizens Gas Light Company the following memorial was ordered spread upon the minutes of the Company:

"Mr. George J. Whitney, one of the Directors of this Company, died on the 31st day of December, 1878.

"From the organization of this Company, to the time of his death, Mr. Whitney was a Director and President of this Company.

"To its best interests he devoted his great energy and good judgment; and to his earnest efforts on its behalf this Company owes much of its standing and success.

"To his associates he was ever courteous and obliging.

"To the employees of the company he was generous and considerate.

"He was liberal in his views, and frank in the expression of them.

"He had secured the respect and affection of his associates, and the confidence of the community; the best evidence of a valuable and useful life.

"To this city, and to this Company, his death will prove a great loss.

"The Directors have, therefore, entered this memorial upon their records as a slight testimony of their respect and esteem."

Reduction in the Price of Gas.

On account of the efforts that people feel constrained to make on every hand to reduce expenditures, and upon the assurance of many friends that low rates would induce increased consumption, the Delaware Gas-Light Company has reduced the price of gas to $2 per thousand feet, with 25 cents per thousand feet to be added where prompt payment is not made, to take effect Jan. 1.

This has been resolved upon as an experiment, the company being determined to respond in the most generous spirit to every reasonable request of the people and the city. Considering the price of coal at this point, and the extent of mains laid in our streets in proportion to the gas consumed, this is a lower rate than has been made, or even asked, in any town in Ohio; and is, in fact, ruinously inadequate unless the consumption shall be largely increased.

When the late Judge Williams and his associates became proprietors of the Delaware Gas Works, they were largely influenced to make the purchase by a desire to provide such facilities for lighting the city as its growing importance deserved. It will be remembered that the old works, including gasholder, purifying apparatus, and all the street mains (which were of wood) had to be replaced, so that the company might be prepared to furnish its customers with an adequate supply of the best quality of gas. This involves an expenditure of capital much larger than had been anticipated, and in consequence the investment, considering the hazardous character of the business and the large percentage of waste and deterioration in apparatus and material, has never been a paying one.

No dividend was ever made until about eighteen months ago, and even at the rate fixed by the last contract with the city ($3 per thousand feet) the per centage upon the money actually invested, with the present rate of consumption, yielded but a very moderate return, considering the character of the business.

About two years ago the company voluntarily reduced the rate to $2.70, allowing the city the benefit of the reduction, notwithstanding its agreement to pay $3 until October, 1880, as they now propose to do in reference to the present reduction. The company, regarding the enterprise as one of public utility, has not felt disposed to enter into any controversy with the city or its inhabitants, in whose prosperity the shareholders are so largely interested; and have therefore always been ready to make any concession, short of the sacrifice of the large capital invested, to avoid such controversy.

Surely the intelligent people of Delaware will not underestimate the importance of having the streets, business houses, and private residences of such a city properly lighted—the importance, we mean, to its business prosperity and its rank and standing as a city.

It is therefore confidently hoped that this liberal experiment of the company, at rates so unprecedently low, will be duly appreciated and responded to in the most generous spirit by the public.

T. C. Jones, President.

C. M. Converse, Secretary.

D. Wagner, C. Hills, S. Moore, V. T. Hills, Directors.

Delaware, O., Dec. 23, 1878.

Corporate Gas-Stove Vendors.

At a special meeting of the Leeds (England) Town Council, on Wednesday, the subject of gas stoves came up, and, in the first place, Alderman Bower, chairman of the Gas Committee, moved a resolution to the effect that the Council should recommend the Parliamentary Committee, in conducting the proposed Improvement Bill, to withdraw therefrom at the proper time the provisions relating to the supply of gas stoves. He said that it would be remembered that the Gas Committee passed a resolution which was adopted by the Council to insert in the proposed Improvement Bill a clause giving powers to supply gas stoves, either by renting them or without charge, as might from time to time be determined by the Council. In the wording of the clause in the bill words were inserted that they were not only to have these powers, but powers to "manufacture gas and other stoves." Now, it was not the intention of the Gas Committee or the Council to take upon themselves the business of manufacturing gas stoves, and with regard to "other stoves," he did not know the meaning of the words in the clause. He supposed an oven might be called a stove, and certainly it was not the intention of the Council or the Gas Committee to include such stoves. Seeing these words had occurred in the notice, the subject came before the Gas Committee at its last meeting, and they determined to ask the Coun il to adopt a resolution to withdraw at the proper time the provisions relating to the supply of gas stoves. He was quite sure these stoves would be a benefit to the town, and he was equally satisfied that it was not the intention of the Gas Committee or the Council to interfere with any trade by becoming sellers of these stoves. Rather than decrease the sale, he believed that if these powers had been adopted many persons would have purchased their own stoves, and the trade would have been increased.

Mr A. Brown seconded the motion. They had given the people an idea, and he had no doubt if they wished to purchase stoves they would do it for themselves.

Mr. Scarr expressed his regret at the withdrawal of the resolution, referred to the advantages of cooking by gas, and hoped that the matter would be revived.

Mr. Baker, replying to the last speaker, maintained that the original proposal of the committee was not in keeping with the dignity of the Council, and would have interfered with the legitimate business of the tradesmen of the town. He hoped the matter would now be buried and would never have a resurrection. [A laugh, "Hear, hear," and "No, no."]

Mr. Scarr—It will, if I live.

Alderman Tatham said he hoped the Committee would at any time bring forward whatever they thought to be for the public good, and the Council would judge of each upon its merits, irrespective of private interests. [Hear, hear.]

Mr. Batley denied that the Committee's proposal in its original form would have interfered with the manufacturers of gas stoves. He regretted that the object had been defeated by somebody's error; and he would be glad to know if the Gas Committee could not carry it out without Parliamentary powers.

The Town Clerk replied that there was no legal

power whatever, unless granted by Act of Parliament, to lend out gas stoves in the way suggested by the Committee. He had taken the opinion of the most eminent counsel on the gas question, who confirmed this opinion.

Mr. North said he regretted the now inevitable withdrawal.

Mr. Beckworth asked whose fault it was that the Council was placed in its present absurd and unpleasant position of withdrawing this part of their bill.

The Town Clerk said the clauses of the bill were drawn by Parliamentary counsel, and were as comprehensive as possible in scope.

Mr. Spark and Mr. Barker supported the withdrawal of the clause.

Alderman Lupton remarked that, as the argument was used the other day that stoves would increase the consumption of gas, a gentleman who was present said: "Yes, quite true; and if you give the people gin, they'll consume a good deal more water." [Laughter.] In the Committee he (Alderman Lupton) contended that no committee had a right to override the decision of the Council, and if it was intended that they should discuss this question they should have had timely notice of it. He did not like the position in which they were placed. He was told it was because certain words had been inserted in the Bill by their Parliamentary agents which rendered it necessary that they should withdraw the clause. He did not like this sort of thing, but he thought there was something further behind the scenes which had not been brought prominently before them that day. He believed that they were bowing before the power of which he gently reminded them at the last meeting. In deference to public opinion they were withdrawing this clause from the bill, and his own opinion was that, whatever might be the opposition to the gas stoves, there was ten times more opposition on the Hunslet Moor question. [Cries of "No, no."]

Alderman Lowley opposed the withdrawal of the gas stove clause.

Upon a division, the motion of Alderman Bower for the withdrawal of the proposed clause was agreed to, only five members voting against it.

The managees of the Leeds Corporation Gas Works have made a mistake—and have had the courage to confess that they have done so. A short time ago the Gas Works Committee received a report—to which we alluded at the time—from their engineer, in which that gentleman set forth a voluminous mass of statistics as to the cost of production and maintenance, as well as a variety of suggestions, by the adoption of which it was urged the Corporation might with profit devote greater attention than before to the subject of selling its gas for heating purposes. On the strength of this no doubt bona fide report the Committee passed a resolution under which they determined to supply gas stoves for heating and cooking purposes "gratuitously or otherwise"—probably, we should say, "otherwise"—so as to create a stronger demand for gas in the daytime. Acting upon, and up to the spirit and text of, this resolution, the authorities are stated to have purchased several hundred pounds worth of such stoves, when it appears to have occurred to some one or other that it might be as well to ascertain whether the Corporation had or had not the requisite legal authority to pursue this line of action.

Accordingly the Act of Parliament was consulted, and was found to contain no such provision, so that the Corporation found itself in the awkward predicament of having taken a course, in carrying out which the ratepayers' money had been unlawfully expended, for which there was not the slightest power. This being so the Committee was hastily summoned, and its constituent members laid their several heads together in order to devise a remedy for their error, and to take steps for giving them the wished for authority to carry on the business they had commenced. It is not recorded how the matter was investigated, or precisely what was done, but the outcome of the Committee's cogitation was that in their Parliamentary notice for the coming session the following clause found a place:—

"17. To authorize the Corporation to manufacture, purchase, sell, let on hire, erect, and otherwise deal with gas and other stoves and apparatus for cooking and heating, and to levy, receive, and recover rates, rents, and charges for the sale and hire of such stoves and apparatus."

So far, so good. Some intrusive and inquisitive individual appears to have gone further, however, and to have again raised the question as to the right and policy of a body such as the Corporation to possess unlimited power to manufacture stoves—which would in reality mean that a few enterprising spirits on the Gas Committee might at any time commit the ratepayers to an extent which would virtually be limitless, embracing, as it would, or at any rate might, the carrying on of foundries, iron or brass works, fitting shops, etc., on any imaginable scale. What again transpired we do not know, but the general result of this second consideration of the matter has been that the Gas Committee has held another meeting, at which it has been resolved to wholly withdraw this particular clause from the new bill, the reasons given being that the extended power which the legal phraseology of the measure would give to the Corporation by the words "manufacture" and "other stoves" was not intended or passed by the Committee. Thus the matter stands at present. The new action of the Committee has met with the approval of the whole Council, not to mention that of the inhabitants of the town. Thus the matter has been lightly got rid of, but the incident should serve as a warning to other too venturesome corporations and gas companies, whose undertakings are already sufficiently gigantic without their embarkation in a branch of business which can be quite as well, if not better carried on by the members of our trade in the usual course of their business.—*Ironmonger, Nov.* 30.

A New "Mash-een."

How Charles Raynor Makes a Fuel which is Cheaper than Wood—Something about Gas and the Gas Works.

Charles Raynor, the wide-awake Superintendent of the Gas Works, has been inventing something again. When he commenced selling crushed coke for fuel he was obliged to employ men to crush it with mallets This was necessarily slow work, and Charlie cast about for some way to lessen the expense. The result of his labor is a queerly constructed machine, which crushes a ton of coke every 30 minutes. Mr. Raynor took the old steam pump in the gas works and made of it an engine which is his power. This runs a cylinder on which are several cams; as these revolve they catch the handles of four hugh mallets, which rise and fall rapidly. These mallets are directly over the grated bin, into which is fed the coke, and which drops through the bars as fast as it is crushed The coke is crushed very easily, and the machine turns it out as fast as one man can feed it in.

We are well assured that the mass of our citizens have no idea of the cheapness and desirability of crushed coke for fuel, but the trade of the gas works in this line is rapidly increasing. The ton price is about eleven cents per bushel, and it has been demonstrated that a good large cook stove will consume about fourteen bushels per month; this would make the cost of fuel per month $1.50. The same cook stove will burn $6 worth of wood in a month. We advise our citizens to make a trial of this fuel.

In strolling about the gas works we find that Mr. Raynor has made many improvements. He now burns tar under his retorts, and saves about 50 tons of coke per day.

We were pleased with some experiments that were tried on gas burners in the office for our benefit. The trouble with gas, in nine cases out of a hundred, comes from bad burners, or from the ignorance of people who put them on. We assure our citizens that if they will let Mr. Raynor overhaul and fix up their burners they will get a better light, and then they can reduce their own gas bills. Call at the gas office, on Winter street, and let Mr. Raynor explain the principle to you.—*Exchange.*

Uranine.

This is the most recently discovered, and perhaps the most remarkable, of all the coal tar uranilin group of coloring substances, now so extensively used for the adornment of the finest fabrics. Uranine is said, by chemists, to be the most highly fluorescent body known to science. Its coloring power is astonishing; a single grain will impart a marked color to nearly five hundred gallons of water.

A most interesting experiment, which anybody can try, consists in sprinkling a few atoms of uranine upon the surface of water in a glass tumbler. Each atom immediately sends down through the water what appears to be a bright green rootlet; and the tumbler soon looks as if it were crystal full of beautiful plants. The rootlets now begin to enlarge, spread and combine, until we have a mass of soft, green-colored liquid. Viewed by transmitted light, the color changes to a bright golden or amber hue, while a combination of green and gold will be rendered, according to the position in which the glass is held. For day or evening experiment nothing can be prettier than these trials of uranine, which are especially entertaining for the young folks. We are indebted for examples of the color to the editor of the *Scientific American*, who are sending specimens, free of charge, to all their readers. [illegible] scription to the paper is $3.20 for a year, $1.60 half year; and a better investment for the money could hardly be named.

Solidification of Petroleum.—A very curious effect is produced on the oils of petroleum, even those of the least gravity, by the addition of powdered soapwort (*Saponaria*), an herbaceous plant of the order *Caryophyllieæ*. On digesting the powder with water, and mixing it with the oil, the latter forms a very thick mucilage, so that the vessel in which the experiment is made can be turned topside down without spilling the contents. What is still more singular is that if a few drops of carbolic acid be added, and the mucilage be shaken, it becomes in a few minutes perfectly liquid again.—*Ironmonger, Nov.* 23.

New Laws of Expansion.—M. M. Levy deduces from the two fundamental propositions of thermo-dynamics the following corollaries:—1. The internal heat of a body cannot be any single function of the specific volume and of the temperature of that body; it can only be the sum of two functions—one of the volume alone, the other of the temperature alone. 2. The same thing is true of the quantity which Clausius [illegible] the *entropy*. 3. Hence, the pressure which a body supports, so long as the body does not change its state, can only be a linear function of its temperature; in other words, if any body whatever is heated, under constant volume, the pressure which it exerts on the immovable walls of its enclosure can increase only in proportion to its temperature.—*Comtes Rendus.*

Decomposition of Wood Tar at a Red Heat.—A. Atterberg.—The author mentions that the results obtained by Libermann, Barg, Salzmann, and Wichelhaus agree with his own observations on the tar of pine wood. By passing the tar and the less volatile tar oil of the Swedish "wood-oil" works through iron tubes filled with coke at bright redness he obtained a tar containing all the important constituents of coal tar. It yielded 7 per cent. benzol and toluol; it was rich in naphthaline; it contained a tolerable quantity of anthracene, but little phenol. At incipient redness were obtained 10 per cent. toluol, containing a little benzol; phenols boiling between 190° and 220°, but little phenylic acid. 0·3 per cent. of anthracene, but no naphthaline.—*Chemical News.*

Gas Stocks.

Quotations by G. W. Close Jr., Broker and Dealer in Gas Stocks.
(with W B Scott & Co.,)

24 Pine Street, New York City.

January 16, 1879.

☞ All communciations will receive particular attention
☞ The following quotations are based on the par value of $100 per share.

	Capital.	Par.	Bid.	Asked.
Gas Co.'s of N. Y. City.				
Central	466,000	50	—	75
Harlem	1,800,000	50	25	30
" Bonds	170,000			103
Manhattan	4,000,000	50	155	165
Metropolitan	2,500,000	100	101	105
" Scrip	$1,000,000	...	85	92
Mutual	5,000,000	100	50	55
" Bonds, gold	900,000	1000	90	97
Municipal	1,500,000	100	92	98
" Bonds	750,000		95	95
New York	4,000,000	100	80	85
Nothern	270,000	50	—	100
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	118	125
Citizens	1,200,000	20	50	60
" Scrip	320,000	1000	90	95
Peoples	1,000,000	10	20	30
" Bonds	325,000	...	--	95
" Scrip	300,000	...	75	80
Metropolitan	1,000,000	100	50	60
Nassau	1,000,000	25	50	56
" Ctfs.	700,000	1000	—	90
Williamsburgh	1,000,000	50	70	75
" Scrip		...	88	92
Kings Co	200,000	100	70	80
Union Co. E. N. Y.		25	—	50
Richmond Co., S. I.	300,000	...	60	85
Out of Town Gas Companies.				
Bath, Maine	70,000	100		
Buffalo Mutual, N.Y	750,000	100	65	70
" Bonds	200,000	1000	95	100
Baltimore, Md	2,000,000	100	95	98
" Ctfs., gold	1,000,000		95	10
Bayonne, N. J		100		90
Brockport, N. Y	25,000	100	...	80
Citizens, Newark	918,000	50	85	91
" " Bds.	124,000	—	105	10
Chicago Gas Co., Ills			128	13
Cincinnati G. & C. Co.				190
Derby of Conn	160,000	100	60	80
East Boston, Mass		25	114	120
Elizabethtown, N. J.	300,000	20	—	130
Fort Wayne, Ind.		100	...	—
Hannibal, Mo	100,000	100	95	100
Hartford, Conn	700,000	25	140	148
Hempstead, L. I.	25,000	100	...	—
Jersey City	386,000	20	120	130
Jamaica, L. I.	25,000	100	...	—
Jacksonville, Ill.	120,000	50	82	...
Lewistown Maine	400,000	100	70	80
Lima, Ohio,	60,000	100	—	...
Bonds	30,000		90	
Laclede St Louis Mo.	1,200,000	100	—	75
Long Branch		20	30	40
New Haven, Conn		25	136	152
Peoples, Jersey City		...	—	80
" " Bds.				95
Peoples of Albany	650,000	100	10	17
" Bonds	350,000	1000	—	-
Peoples of Baltimore		25	44	48
" Bonds			106	—
Plainfield, N. J.	80,000	100	—	105
Perth Amboy		25	—	95
Rochester, N. Y.		100	50	60
Woonsocket, R. I.	150,000	100	95	...
Halifax N. S.	400,000	40	148	150
Hamilton, Ontario	150,000	40	117½	
San Francisco Gas-Co., S. Fr'isco Cal.			95	95½
Pittsfield, Mass			120	130
Rondout & Kingston			75	80

The Citizens of Newark has paid its quarterly dividend of 2 per cent. Brooklyn Gas Co. paid a dividend of 5 per cent. Jan. 1. The Central paid its semi-annual dividend of 3 per cent.

100 shares of Manhattan gas stock sold at auction at 155½.

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To Gas Companies.

A Practical Gas Engineer,

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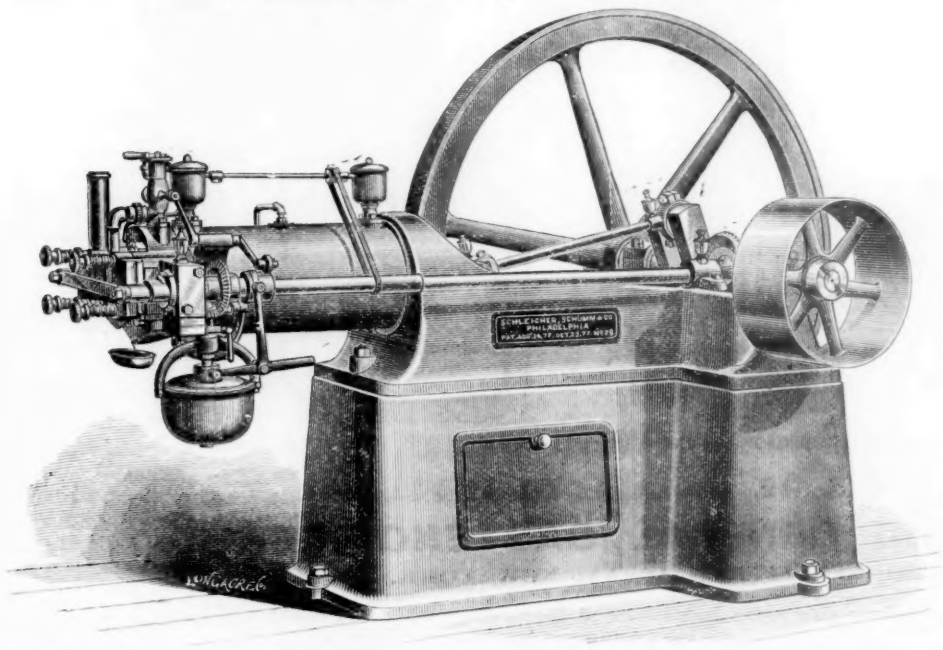

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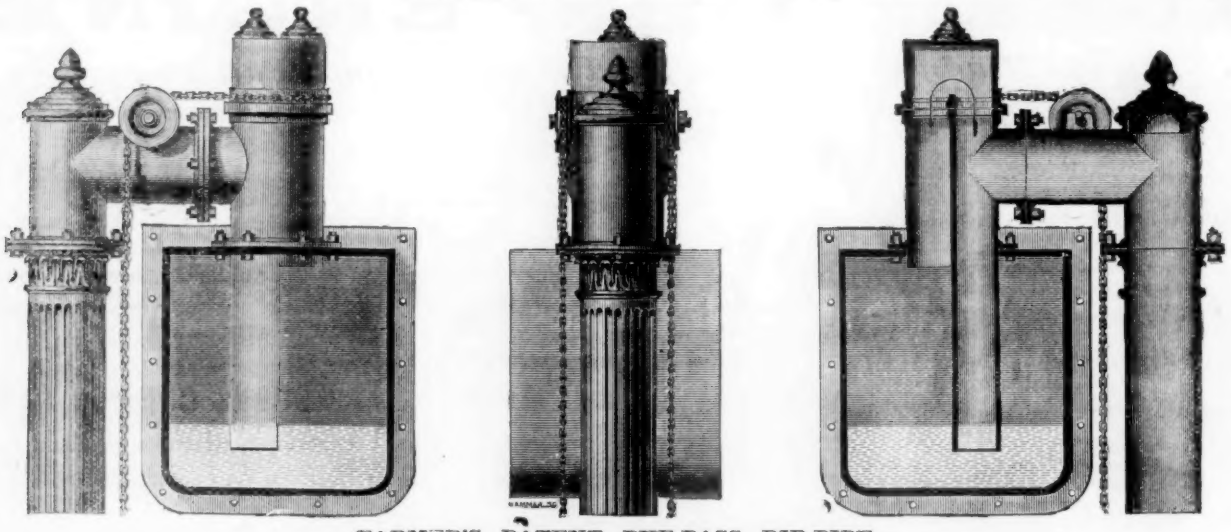

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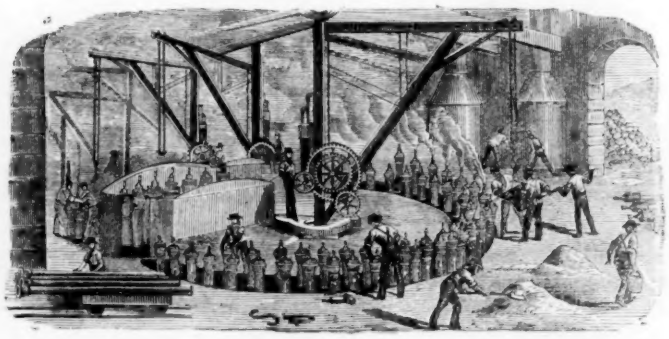

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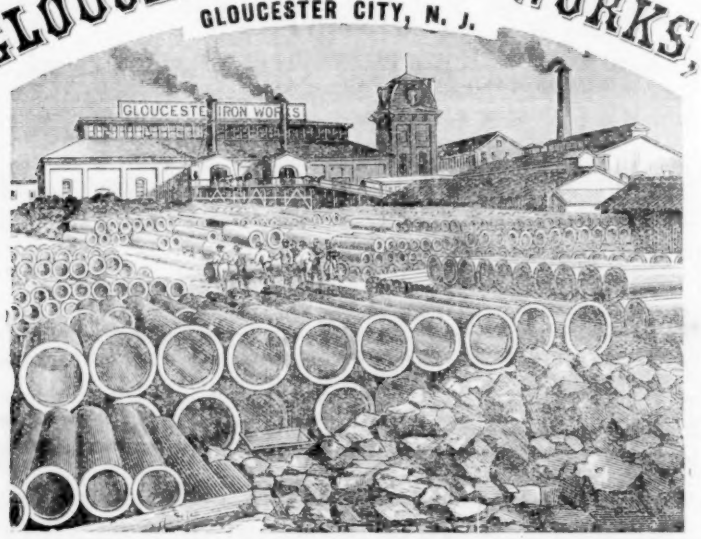

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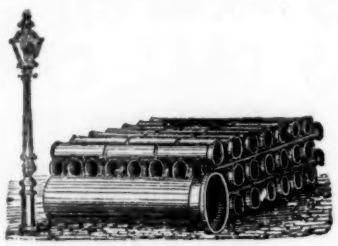

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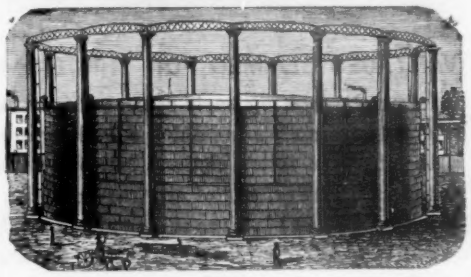

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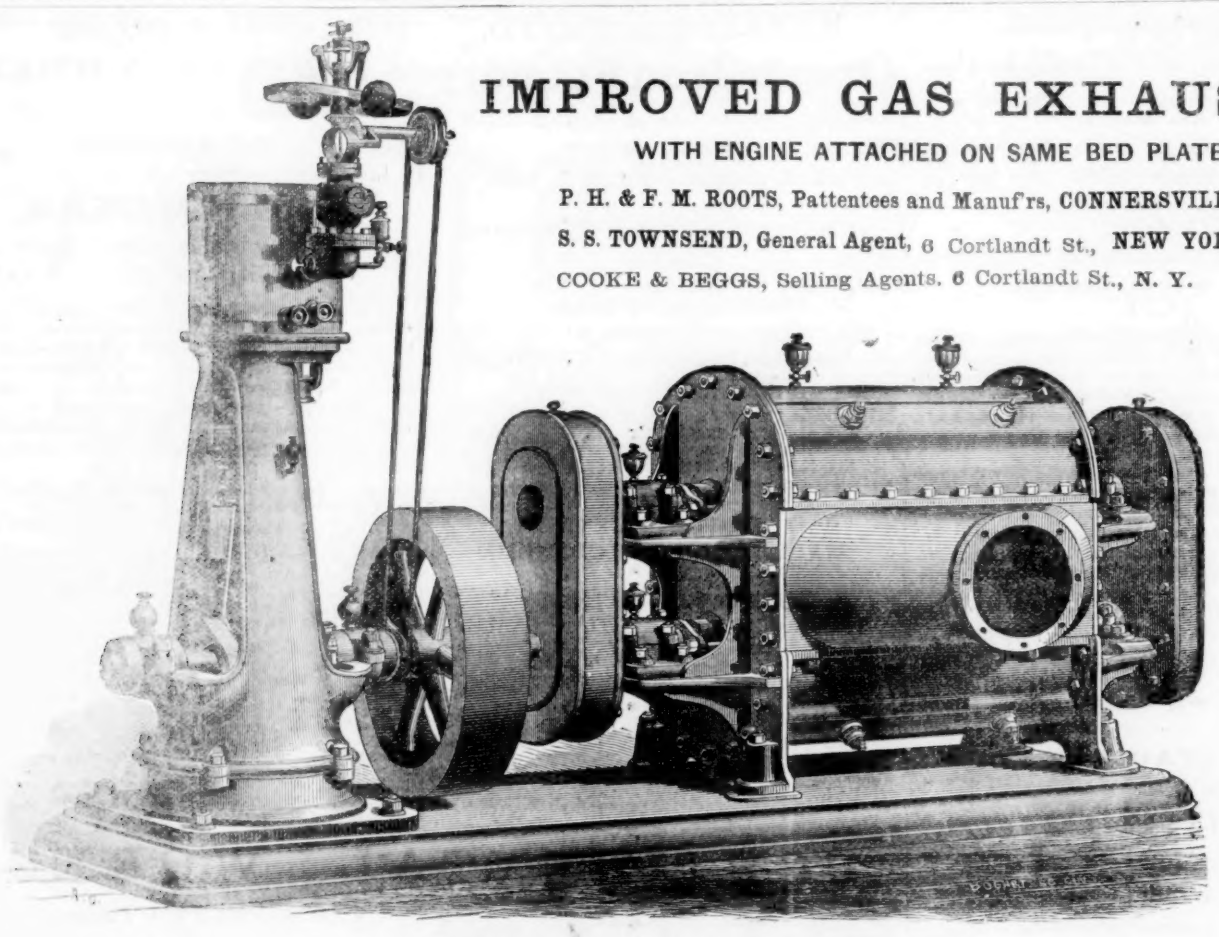

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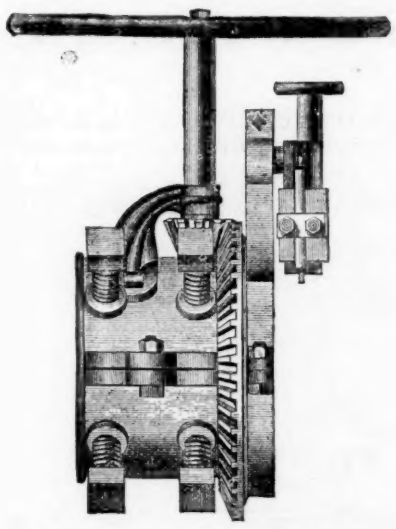

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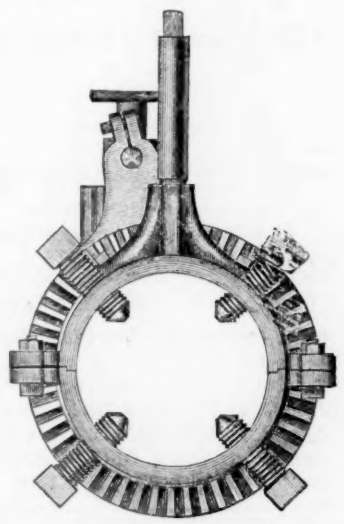

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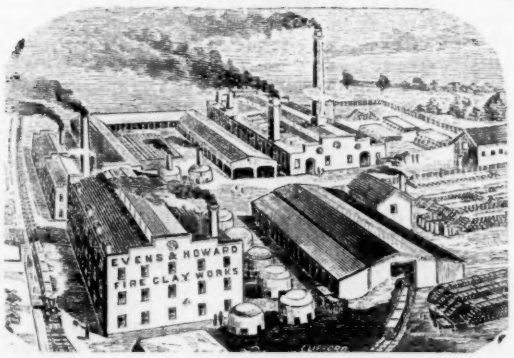

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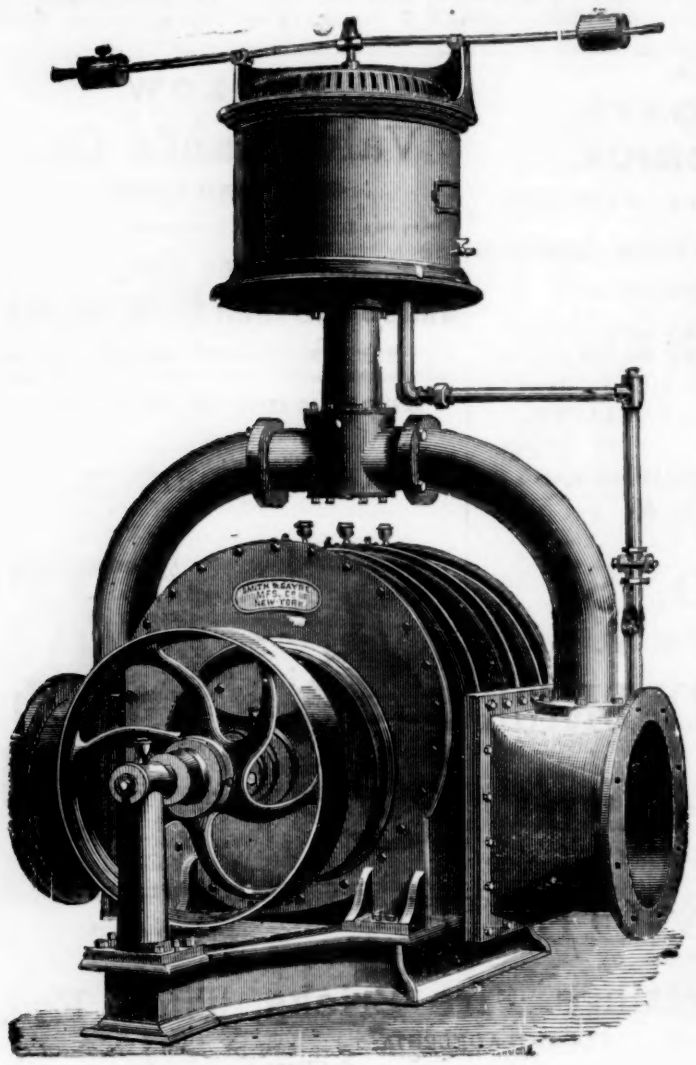

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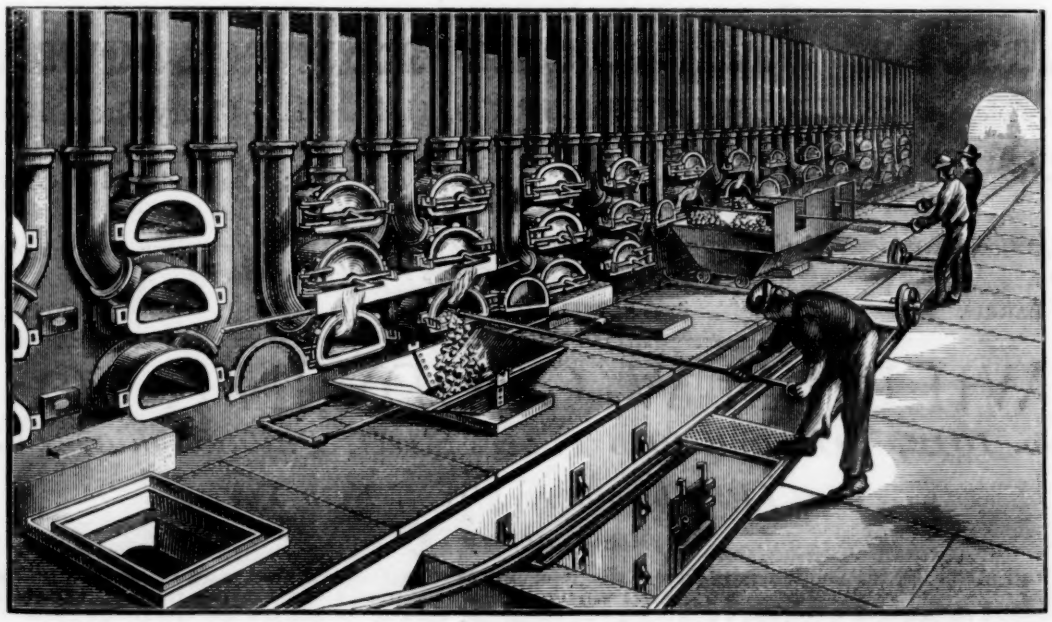

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